SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE PRESENT STATUS AND THE FUTURE OF HYGIENE OR PUBLIC HEALTH IN AMERICA[1]

During the past few years an increasing and now insistent demand has been heard in this country for better facilities for the training of public health officials. This demand has come from members of the medical profession, chiefly those engaged in official positions as officers or commissioners of health for cities and states, from sanitary engineers, and from various philanthropic societies whose aim is the betterment of social conditions among the poor in our great cities and in our rural communities. With the last this demand is associated with a demand for more enlightened instruction for the general public in matters affecting their health. At this time when these various desires are but an index of the awakening of interest throughout this country in that branch of science known as hygiene or public health, it becomes a matter of vital necessity for those of us who are working in this field to clearly formulate the underlying principles of this science, its scope and its needs, and present them to the public and especially to those who hold the fate of our great institutions of learning in their grasp and under their direction.

HYGIENE IN GERMANY AND AUSTRIA

Despite the fact that an American-born scientist, Count Rumford, of Munich (Benjamin Thompson of Concord and Boston), was the first to inaugurate and carry out a comprehensive movement for

[1] Read at the May, 1915, meeting of the Association of American Physicians.

the betterment of living conditions among the very poor, during the course of which he made a most accurate and painstaking study of the many factors leading to poverty and ill-health and suggested remedies for them, the modern conception of hygiene was given the continent of Europe by Max von Pettenkofer, the first professor of hygiene in Munich and indeed the first professor of hygiene in any German university. A pupil of Liebig and Voit and a well-trained chemist, Pettenkofer first served as professor of chemistry in Munich, but in 1865 transferred his activities to the science of hygiene, a professorship of which was established for him in this Bavarian institution. More than any other man of his time, Pettenkofer saw clearly the prevailing chaos in the facts and theories relating to the science of health and especially in regard to the infectious diseases. At that time epidemic after epidemic of typhoid fever devasted the population of such cities as Munich and Vienna, Asiatic cholera was always knocking at the doors of central Europe and frequently obtained admission, while other zymotic diseases spread like wildfire from person to person when once started in a community. The laws passed to control these epidemics were ineffective and the mortality from disease extremely high. The single exception to the prevailing helplessness was the Jennerian vaccination which had placed smallpox in the sphere of controllable diseases. Pettenkofer not only realized the inadequacy of the methods employed to limit the spread of disease, but he also saw that the fundamental difficulty lay in the ignorance of the medical profession in regard to the mode of transmission of infections from one individual to another. In this great crisis, for such indeed he felt it to be, Pettenkofer raised a powerful voice and demanded that the various facts relating to disease "en masse" should be thoroughly studied by experts just as the symptoms and pathology of individual cases were being studied by experts, that after the fundamental facts had been observed on a broad basis, theories to explain these facts should be formulated and submitted to the rigid test of experiment, to the end that proper conclusions from fact, theory and experiment might be drawn and measures in accord with these conclusions be carried out. In other words, Pettenkofer demanded that the empiricism of hygiene should be converted into a science. To accomplish this he further insisted that departments of hygiene be established in the various universities, that proper equipment be provided to gather the data and test the theories of hygiene, and that trained scientists be given the opportunity of carrying out this work. The widespread agitation coming from the movement originated by von Pettenkofer resulted in the establishment of a department of hygiene in the University of Munich, the selection of von Pettenkofer as professor and the construction of a hygienic institute. This institute founded in 1865 still stands, I believe, although plans for a new building upon somewhat more modern lines have now been completed.

From this brief résumé it may be seen that Pettenkofer was really the founder of modern hygiene, at least in so far as the German-speaking races were concerned. He occupies indeed the same position in regard to hygiene that Virchow does in pathology.[2] The radical movement in

[2] An interesting analogy is also evident in the domain of therapeutics. In this science Schmiedeberg, a pupil of Bucheim, who founded the first laboratory for the scientific study of drugs in Dorpat, realized the inadequacy of the existing knowledge of the composition and the action of the various remedies employed by the medical profession largely on an empirical basis. He demanded that the medical profession turn from the clinic to the

hygiene fathered by him made a profound impression upon Europe, especially upon Germany and Austria. Professorships were established in the leading medical schools, first in Bavaria and then in other parts of the German empire, thoroughly trained men were put in charge of the administration of sanitary laws and the attempt made to limit the spread of the infectious diseases by scientific methods. The new knowledge acquired by Pettenkofer and his pupils, and the laws promulgated at their suggestion soon began to have a definite influence upon the mortality returns. In the city of Munich, for instance, the sewage system was reconstructed and proper methods established for drawing off human and animal wastes, a new and pure supply of drinking water was obtained, old, ill-constructed houses were pulled down and air and sunshine admitted to the darkest sections of the city. A special corps of sanitary police was instituted, the members of which were given extraordinary powers so that they could visit every quarter of the city, and enter every dwelling to enforce the execution of the new sanitary laws. As a result of these sweeping changes the mortality from zymotic diseases fell rapidly in Munich and typhoid fever practically disappeared. In Vienna also, where Gruber, a pupil of von Pettenkofer, became professor of hygiene in the university, a similar change took place. Here was a city built within narrow walls, the population crowded together in unsanitary quarters with a water supply from surface wells sunk in a sewage-permeated soil. Sweeping reforms were instituted in this old medieval town, a new method of sewage disposal established, a new water supply obtained and in a surprisingly short time the typhoid mortality was cut in two. Whereas in 1874 it had been 15–16 per thousand, by the end of two years it had fallen to 7–8 per thousand and subsequently steadily diminished.

laboratory, study the chemical composition of drugs, determine their action by animal experimentation and endeavor to explain this action by the facts and theories of physiology. Under the leadership of Schmiedeberg the new science of pharmacology was established to take the place of the older science of therapeutics.

Under the stimulus of von Pettenkofer the new science of hygiene developed rapidly and from his institute in Munich his pupils passed first to one and then to another of the European universities as the chairs of hygiene were founded. Thus Buchner became associated with hygiene in Munich, Gruber went to Vienna, von Fodor to Budapest, Flügge to Göttingen (later to Breslau), Hofman to Leipzig, Lehmann to Würzburg, Rubner to Marburg, Pfeiffer to Rostock and Prausnitz to Gratz. The science of hygiene was established upon a firm basis and it is not too much to say that the movement inaugurated by von Pettenkofer was one of the most important movements in the science of medicine of the nineteenth century.

The Munich school of hygiene was developed in the days before modern bacteriology was dreamed of however, the etiological agents of disease were unknown and much of the work of the great investigators had to be carried out upon a hypothetical basis. This is best shown by the famous *x y z* hypothesis of von Pettenkofer by means of which he attempted to explain the spread of the diseases in which the intestinal tract is involved, typhoid fever, cholera and dysentery, the so-called diseases of the soil or Bodenkrankheiten. The kernel of this hypothesis lay in von Pettenkofer's belief that the unknown etiological agents of these diseases must undergo a process of modification or ripening in the soil before they are in a condition to produce the disease in other individuals. With the rise of the new science of bacteriology as the result of

the wonderful and brilliant investigations of Robert Koch and his immediate pupils, especially the discovery of the responsible parasites of anthrax, tuberculosis, Asiatic cholera and typhoid fever, the Munich school of hygiene received a staggering blow. Here were the hypothetical etiological agents of disease capable of demonstration under the microscope and of cultivation in the laboratory. Why waste one's time indeed in arguing about an unknown factor when this factor had been discovered and identified and the facts relating to it could be accurately studied? This was especially the case with Asiatic cholera where methods had been devised for the accurate bacteriological examination of suspected cases by the use of which an almost absolute diagnosis could be made in forty-eight hours and the infected individuals quarantined, the simplest possible method of preventing the introduction of this fearful scourge into any community. But the Munich school of hygiene died hard and in the long and somewhat bitter controversy between the old and the new, between Pettenkofer and his pupils and Koch and his, most important facts bearing upon the etiology of the infectious diseases were established. Gradually, however, the newer and more correct theories of the modern bacteriologists supplanted the older and often incorrect theories of the Pettenkofer school and in 1885 Koch became professor of hygiene and bacteriology in the University of Berlin. This set the pace and within the next few years the various professorships of hygiene as they became vacant were filled by the appointment of men trained in the modern bacteriological technique. Thus Gaffky, the discover of the typhoid bacillus, went to Giessen, Loeffler, the co-discoverer with Klebs of the diphtheria bacillus, to Griefswald, Hueppe to Prague, von Behring to Halle and Marburg, Carl Fraenkel to Marburg and Halle and Gärtner to Jena. At the same time hygienic institutes corresponding somewhat to our municipal health laboratories were founded in many of the larger cities of Germany and Austria to provide for the accurate bacteriological diagnosis of the infectious diseases. The largest and best-equipped of such institutes is probably that of Professor Dunbar in Hamburg, one of the few American-born scientists to make his career in Germany. A more recent institute of the same general character is that of the city of Frankfurt a. M. under the able direction of Professor Neisser. With the single exception of the laboratories of the City of New York there are no institutions in America which are founded upon quite the same broad combination of routine work and advanced research as are these.

As a result of the various factors operating to develop the modern science of hygiene in Europe we find that this subject is now firmly established in all the German and Austrian universities. It is a principal or major subject in every medical school and there is an "ordentlich Professor" of hygiene in every university where medicine is taught. Every student of medicine must pass a rigid examination in hygiene before he can obtain his degree and before he can practise his profession. As was to be expected from the somewhat diverse lines of development hygiene has taken we find men of various tendencies occupying the professorships. On the one hand Flügge and Gruber represent the older or Munich school at Berlin and Munich, both trained in the Pettenkofer methods but both greatly influenced in their thought and work by the newer bacteriology of Koch. In Berlin also before the appointment of Professor Flügge, hygiene was brilliantly represented by another product of the Munich

school, Professor Rubner, now professor of physiology. On the other hand, many other chairs of hygiene in Europe are held by the bacteriologists as by Kruse in Königsberg, by Fischer in Kiehl, by Uhlenhuth in Strassburg, by Kolle in Berne, by Schottelius in Freiburg i. B., and by Neumann in Giessen. At the same time hygiene is taught in Vienna by Shattenfroh and Grassberger who clearly unite the two schools, while in Budapest von Lieberman is associated with von Fodor, and may be said to approach the subject more from the standpoint of the physicist.

Despite the great diversity in training of the various hygienists in Germany and Austria, the subjects they teach and study are much the same in the different universities, approached necessarily however from different viewpoints. The fundamental principles of hygiene as applied to vital statistics, heating, lighting, ventilation, clothing, disinfection, sanitation, water and milk supplies, sewage disposal, nutrition and food values are taught to all medical students while special emphasis is laid upon demonstrations which show the mode of transmission of the infectious diseases. Lecture courses in theoretical hygiene are compulsory, laboratory courses in practical hygiene are attended by the majority and all students who are candidates for degrees in medicine must pass a rigid examination in hygiene before graduation. At the same time special courses in hygiene are offered in all the hygienic institutes. They cover a variety of subjects and include such topics as school hygiene, mental hygiene, the hygiene of inheritance, nutrition and systematic instruction in the principles of infection and immunity. Finally elementary bacteriology is taught the medical students in many of the hygienic institutes which in a few instances provide facilities for the cities where the universities are located for diagnostic work in connection with the infectious diseases. No matter how seemingly diverse the subjects or how varied the interests of the many workers in the field, hygiene is a distinct scientific entity in central Europe to-day, the object of whose teaching is the demonstration of all the available facts and theories relating to disease in bulk as distinguished from individual cases of disease.

HYGIENE OR PUBLIC HEALTH IN GREAT BRITAIN

During the period which saw the establishment of hygiene on a modern basis in Germany and Austria, the same science was being developed in England under the name "public health." In Great Britain the system of local control of public affairs had spread more widely than in any of the continental countries in consequence of which the local authorities were enabled to dictate their own mode of government. Local organizations were formed to control all matters relating to the health of the community and the system of local government boards with their peculiar privileges and responsibilities has resulted. This system represents indeed Great Britain's especial contribution to hygiene in the last century and the years 1847 when medical officers of health were first appointed, 1848 when they were required to be qualified medical practitioners (Public Health Act), 1855 when every vestry and district board in London was required to appoint one or more medical officers of health and 1872 when the new Public Health Act forced every sanitary authority outside of London to appoint a medical officer of health, formed the especial landmarks in this chronological development. Long before 1847, however, English physicians had devoted time, energy and thought to the problems of hygiene and the names

dear to the heart of every Anglo-Saxon are scattered over the pages of English medical history. Thus in 1720 Dr. Richard Mead, the physician to St. Thomas Hospital, published his "Short Discourse Concerning Pestilential Contagion, and the Methods to be Used to Prevent It," a book which went through seven editions in its first year of life. In 1764 appeared Dr. John Pringle's work on "Diseases of the Army" which was destined to revolutionize sanitary conditions in jails and hospitals as well as in military camps, while the same service was rendered the navy by Dr. James Lind's publication entitled "On the Means of Preserving the Health of Seamen," soon followed by a series of essays concerning the health of the Royal Navy, on "Fevers and Infection" and on "Jail Distemper." Dr. Gilbert Blane's "Observations on the Diseases of Seamen" appeared in 1785 and in 1796, when Blane was serving as chief officer of the Naval Medical Board under the admiralty, lemon-juice was added to the diet of the seamen and scurvy ceased to rage. Dr. George Baker, in 1767, elucidated the etiology of "colic and palsy" in Devonshire and by his demonstration that this was lead poisoning pure and simple first put the study of industrial diseases upon a scientific foundation. More important than any other single discovery, however, and more beneficial from the world-wide campaign it inaugurated against smallpox stands of course Jenner's discovery of cowpox vaccination in 1798.

In the century from 1738 to 1838 England saw its great rejuvenation manifest in its acute religious revivals, its political emancipation, the social liberation of its lowest classes and the destruction of class privilege, the extinction of slavery, the improvement of agriculture, the extension of trade and commerce and the organization of its industries on a firm basis. During all this time great movements were usually associated with great men and the names of John and Charles Wesley, George Whitfield, Adam Smith, Jeremy Bentham, John Howard and William Wilberforce, will always be held in affectionate reverence by those who are alive to the ills of mankind and who love their fellowmen. By 1838 England had been thoroughly purged of many of its ills and when ten years later the first systematic efforts to regulate the sanitary affairs of London began, the government found a population no longer hostile to sanitary reform. During most of the subsequent period one figure looms up persistently in public health in the United Kingdom, Sir John Simon, who bears much the same relationship to English hygiene that Pettenkofer does to German, and who was fortunately also spared till close to the end of the last century.

As a result of the Public Health Act of 1872, it became apparent that the supply of men trained in sanitary science to occupy positions as public health officers was inadequate and the University of Cambridge set about the task of remedying the difficulty. For this purpose it established the system of examining qualified medical practitioners in the principles of hygiene and granting diplomas to those who satisfactorily passed the examination. In this work the great hygienist Parkes was the leading spirit. The diploma granted came to be known as the D.P.H. or Diploma of Public Health, the holders of such diplomas having a distinct advantage over their competitors when they applied for the coveted positions with the various local government boards. The great advantage to any community in having its medical officer of health a trained sanitarian was soon apparent and in 1892 an act was passed

which required every medical officer of health to have a diploma of public health in every district of 50,000 inhabitants or to have served as health officer before the passage of the act. Thus a medical officer of health in Great Britain is not only a qualified practitioner of medicine but is a trained sanitarian as well.

The example set by Cambridge in granting the D.P.H. was soon followed by other universities in the United Kingdom and at the present time this or a similar degree with the same general purpose is granted in sixteen of the universities in Great Britain as well as by the Conjoint Board of the Royal Colleges of Physicians and Surgeons in England, in Ireland and in Scotland. At the same time the various universities offer courses of instruction in hygiene or public health which qualify men to pass the examinations. In general the work required of a candidate covers nine calendar months, thus corresponding to a year's postgraduate work in America. During this period the candidate spends four months in studying the principles of sanitary science in their application to public health problems, "air, water, soil, sewage, food, climatology, bacteriology, parasitology and the general pathology of diseases of animals transmissible to man, etc." (See Nuttall.) Following this he receives instruction in sanitary engineering, food inspection, epidemiology, occupational hygiene, vital statistics and public health laws. Finally during six of the nine months the student must study public health administration under a qualified medical officer of health and during three months must attend a hospital for infectious diseases and acquire training in diagnosis and in preventive methods. In addition to the men who expect to enter upon an administrative career in public health in Great Britain and who are now required to obtain this diploma, many medical graduates take the D.P.H. as a post-graduate degree corresponding somewhat to our Master of Arts and a large number of the most eminent scientists in the medical profession there are holders of diplomas in public health. Whatever else may be said of the public health instruction in Great Britain and however true some of the criticisms leveled at it may be, it must be admitted that this system has resulted in an enlightened control of sanitary measures by competent authorities which is not surpassed by any other country in the world. How well this system fits into the general political and governmental systems of Great Britain is shown by a glance at their mortality returns in which a death from typhoid fever is so rare as to be an occasion for comment or in a study of the distribution of rabies which seldom or never appears in the British Isles. The English conception of public health differs essentially from the German conception of hygiene, however, and while differences are difficult to formulate, it may be said in general that in England attention is focused upon the administrative side of the subject, while in Germany the emphasis is laid upon the theoretical or purely scientific aspects of the science. This does not mean that in Great Britain the scientific side of public health has been neglected or that in Germany the practical side of hygiene has been forgotten. It is nevertheles true that the modern conception of public health has been furnished the world by Great Britain just as the modern conception of hygiene has been developed in Germany and Austria and that there are certain differences between the two conceptions.

The English notion of public health prevails in Great Britain's colonies and some years ago the late Wyatt Johnston, of

Montreal, established a systematic course of instruction in this branch in McGill University which was the first institution in America to grant a diploma of public health.

HYGIENE OR PUBLIC HEALTH IN FRANCE

In France also from early times thoughtful medical men and government officials were deeply concerned with the health of the people and alive to the necessity of studying and reforming sanitary conditions. On July 6, 1902, Dubois, prefect of police in the City of Paris, founded the Council of Health or Conseil de Salubrité with four members, Deyeux, Parmentier, Huzard and Cadet-Gassicourt. The organization of this body was modified by subsequent decrees in 1810 and in 1815, and similar bodies were formed in Nantes and Bordeaux in 1815, in Lyon in 1822, in Marseilles in 1825, in Lisle (Lille) in 1828, and in Rouen in 1831. In 1848, the year that saw the first Public Health Act of Great Britain, the Conseil d'Etat passed an ordinance for general health regulation throughout France. Since that time the administration of health laws has been on a firm and scientific basis in France and many medical men of prominence like Thouret, Leroux and Dupuytren have been members of the various councils of health. In general the administration of health or sanitary laws is in the hands of the department of police (law, etc.), the Conseil de Salubrité being entirely a consultative body. Its decisions have the practical force of laws however and are seldom reversed. At irregular intervals voluminous reports are issued, relating to health, salubrity and industry. The regulations under the caption Health relate to food and its adulterations, poisonous substances found in it, kind of vessels used in its manufacture, etc. Under Salubrity is considered the regulation of anatomical theaters, barracks for soldiers, public baths, street fountains, water supplies, factories, prisons, markets and disposal of filth. Finally Industry covers the bituminous trades, manufacture of candles, slaughter houses, powder mills, white lead factories, and all places where poisonous gases are liberated. From time to time the old regulations are modified to meet the needs of modern civilization and new regulations promulgated. The wonderful sewerage system of Paris and the beautiful gardens for sewage disposal on the banks of the Seine a few miles below Paris are lasting monuments to the genius of the French hygienists, and the leading positions which French authorities occupy in the scientific development of quarantine testify to their soundness and versatility. French hygiene or public health, however, has been especially influenced in its later development by Pasteur and the various institutes named after him and has, to a considerable extent, developed the idea of preventive medicine. The Pasteur Institute in Paris, originally designed for the study of rabies and the preparation of anti-rabic inoculations, soon took on the character of a general bacteriological and hygienic institute in which the problems of all the infectious diseases were investigated. The other Pasteur Institutes in France and her colonies have also been modeled on the same general plan. Hygiene likewise is an important part of the medical curriculum and a number of standard publications are devoted to it.

HYGIENE OR PUBLIC HEALTH IN AMERICA

When we now turn to the consideration of hygiene or public health in America, it is at once evident that the greatest confusion of ideas prevails concerning the subject. Authorities are not agreed upon

even the fundamental definition of the science the development of which has been both sporadic and limited. It is high time indeed that we should have some sort of free discussion of the whole matter particularly as to the best lines for the future growth of the beginnings already made. Certain fundamental facts stand out clearly. The most important of these is that municipal and state authorities have for years recognized the needs of safeguarding the public health and have established various institutions for this purpose, especially our city and state departments of health. Thus as far back as 1856 our state boards of health were well organized and held an important conference in Philadelphia to deal with the vexing question of yellow fever which appeared at Bay Ridge the previous year. The national government has lagged far behind other countries in public health matters however and a national department of health, so vital to the interests and happiness of every citizen of the United States, has thus far failed of establishment. The abortive attempt made to bring about this much needed reform, in the early eighties, led to the foundation of such a department, which led a precarious existence of only two years. Fortunately the Marine Hospital Service has gradually been able to take up many of the duties of a national department of health and has now become in fact and in name a Public Health Service.

In our universities and in our medical schools, while hygiene was early recognized as a major subject by many of our leaders in medical education, this feeling was by no means widespread. Nevertheless important beginnings were attempted and in some instances splendid results followed. As early as 1865, the year von Pettenkofer became professor of hygiene in Munich, the medical college of the New York Infirmary for women and children made hygiene and public sanitation a compulsory part of its curriculum. Even before this the Women's Medical College of Pennsylvania had taught hygiene in association with physiology. The University of Michigan when its medical department was founded in 1850 taught the principles of the sanitary analysis of drinking water to its students, in the early seventies lectures on hygiene were given to both medical and literary students by the late Dr. Corydon Ford, and in 1876 a course of lectures was given on this subject by the present professor of hygiene there. In 1887 the state legislature made an appropriation for a hygienic laboratory which was formally opened in the session of 1887–88. In Western Reserve, in Cleveland, state medicine and hygiene were taught as early as 1881 sometimes in association with pathology and again in connection with clinical subjects. In Harvard lectures on hygiene were given in 1876, and the present department of preventive medicine was established later as a department of hygiene with the late Dr. Harrington as director. In 1892 the institute of hygiene of the University of Pennsylvania was established upon a broad foundation with the gifted Dr. Billings in charge and in this institute we see most clearly the influence of the Munich school of hygiene upon medical thought in America. Foundations of hygiene were likewise provided for in many other medical schools such as the University of California and Cooper Medical School in San Francisco. With the exception of Michigan, Pennsylvania and Harvard however the hygiene which was taught in America was presented either by practising physicians or by health officers whose time was largely occupied by administrative duties and who gave brief and in general unscientific lectures upon public health topics to medical students. The excellent

example set by three of our leading medical schools was not followed, the science of hygiene failed to develop generally and in many instances the older foundations of hygiene were abandoned to make room for subjects regarded as of greater necessity in the medical curriculum. Thus the department of hygiene in Cooper Medical School, now Leland Stanford, gave way to a department of bacteriology. Recently however Western Reserve has reorganized its work in hygiene and has appointed a full-time professor in this branch, a similar change has taken place in Yale and the relatively new University of Chicago has also established such a department. With all this hygiene as a major subject, with a trained scientist giving up his entire time to teaching its principles and studying its problems, exists in but six of our thirty-eight medical schools to-day. What a pitiful showing this makes in comparison with Germany and Austro-Hungary where all the twenty-two universities where medicine is taught have their hygienic institutes or with Great Britain where every graduate in medicine must follow courses in public health and pass examinations in it. I do not mean that many of our medical schools are not making a determined effort to develop the subject of hygiene or that instruction in it is entirely lacking. Indeed excellent courses in public health are given in both Minnesota and Indiana. In the three larger medical schools in New York City hygiene or public health has now become compulsory. At Johns Hopkins too the faculty has long recognized the necessity of further development along this line and the beginnings small though they are have now been made. I merely wish to point out and emphasize that the science of hygiene, one of the most important parts of a medical curriculum, has never reached the same development as an independent subject which has long been attained in Europe, and which has already been reached in America by the scientific branches of medicine, anatomy, physiology, chemistry, pathology and pharmacology, or by the clinical, surgery, medicine and gynecology and obstetrics.

In the same way and possibly as the result of the same influences, hygiene plays but an unimportant part in our state examinations for licensing practitioners of medicine. In but a few states is there a separate examination in hygiene and in some the subject is not even mentioned. Yet there is probably no field in which medical men need training more than in hygiene and in no line of work will his efforts be more beneficial or more appreciated by the community than in the prevention of the spread of infectious diseases by the application of the sound principles of sanitation. The medical profession of America is neither indifferent to the great problems of preventive medicine nor ignorant of its principles however. The long and honorable career of the American Public Health Association and the more recent development of the Section of Hygiene and Preventive Medicine of the American Medical Association testify to the contrary. The indifference to hygiene as a science lies in our universities and in our medical schools and the responsibility for the failure of its development rests clearly upon them.

PRESENT NEEDS

The question now rises as to the especial needs of hygiene, and the conditions which must be met in order that it shall develop. We may best consider this under three divisions.

There is first a definite need and even a necessity for the training of medical students in the science of health, whether the science be labeled hygiene, public health or

preventive medicine. Every man who graduates from a medical school should be taught, some time during his course, the underlying principles of hygiene. He should know what the word ventilation means, for instance, something about clothing, the kinds of exercise suitable for different individuals, the values of foods, how a good water supply differs from a poor one, what good milk is, how a city should dispose of its sewage. Especially should he be taught the mode of transmission of the infectious diseases and the methods of their prevention. This knowledge the well-trained physician of the future must have, not merely that he may advise his patients properly and safeguard their health, but that he may play his part in the community where he lives and lift his voice on the right side concerning that branch of city and state government which most concerns him, the department of health, too often alas merely a pawn in the hands of unscrupulous individuals to move as they see fit in the great game of politics. To accomplish this purpose, namely, the education of the physician, every medical school in this country should have its department or institute of hygiene in charge of a full-time man with a corps of trained assistants. It makes little difference whether the head of this department is a chemist, a bacteriologist or a physicist, since the problems of hygiene must be approached from various angles, but in the organization of the department provision must be made for teaching the subject with reference to chemistry, bacteriology and physics. Didactic lectures in hygiene must be combined with laboratory exercises and the student must acquire first-hand knowledge of water and milk analysis, disinfection, sanitation, and especially the bacteriological diagnosis and the prophylaxis of the infectious diseases. In addition special courses should be offered in such topics as school hygiene, serum-therapy, nutrition and food valuations, etc. The research side should also play a large part in any department of hygiene. It is not sufficient to teach what we know at present about hygiene. The bounds of our knowledge must be constantly widened, new facts acquired and new theories tested.

The relationship of the department of hygiene to the medical school should also be made clear. It is essential that hygiene be presented as a distinct and independent science and not as a phase of bacteriology, or of chemistry, or of physics. How far the department of hygiene should engage in teaching the elementary principles of the sciences whose methods it uses is also an important question but chiefly as it affects bacteriology. This after all is a matter of merely academic interest. Bacteriology must always be taught medical students from the standpoint of the pathogenic bacteria. If the pathological laboratory has the facilities for teaching bacteriology and the staff have the training there is no reason why general bacteriology should not be taught with pathology. Nor is there any reason why bacteriology should not exist as a separate department in the medical school if funds are available for this purpose. At the same time there is no reason why general bacteriology should not be taught in the hygienic institute so long as it does not encroach upon the teaching of hygiene and provided the head of the department has received the proper training and understands the fundamental principles of infection and immunity. Above all it must be remembered that hygiene is a medical subject and a part of medicine. Its methods are the methods of medicine and have been developed in the medical departments of the European and American universities.

Hygiene must therefore always be taught medical students from the medical point of view by medical men.

The second great need in this country is for better facilities for the training of public health officers. The awakening of the public conscience to the necessity of removing health questions from the domain of politics has resulted in the reorganization of many of our municipal and state departments of health while the excellent achievements of others have given them greater responsibilities and increased facilities for carrying out their work. The system of "county health officers" in which employees of the state department of health are empowered to assume local duties either in cooperation with the local authorities or superseding them has now been adopted in two states and marks a signal advance in health legislation. This is an example indeed likely to be followed by a number of states as time goes on. This change in health administration has created a distinct demand for specialists in public health and the medical departments of our universities must now see to it that the men who take up public health as a career are given the opportunities of fitting themselves properly in the science of hygiene or public health. This can probably best be accomplished by organizing courses leading up to the Diploma of Public Health or some similar degree, the possession of which will guarantee that the holder has received expert instruction which will qualify him to act intelligently as an officer of health. Already three of our best medical schools have organized such courses and other universities are contemplating similar enterprises. It is not enough that this or that school shall establish departments for the training of health officials. This movement is one which vitally concerns the physicians of this country and is likely to have an important influence upon the development of American medicine. The medical profession must demand that our health officers be properly trained, that the Diploma of Public Health shall not be awarded to any sort of individual regardless of his preliminary training to be used merely as a lever to help him to acquire a position. There must be some sort of standardization of the courses leading up to the degree and particularly must there be some agreement as to their length and the amount of time which must be passed in preparation for the examinations. Above all American physicians must remember that the health officer, be he county, city or state, has a distinct function, the intelligent exercise of which requires a medical training. It is not enough that our garbage be disposed of, that our drinking water be chlorinated or filtered, the bacteria in milk be counted or the births and deaths of a community be registered, important as these activities may be. It is far more important that the unsuspected and unreported case of typhoid fever or septic sore throat be ferreted out, the typhoid or diphtheria carrier be recognized, the first case of smallpox be differentiated from chickenpox and that the correct diagnosis of the obscure cases of meningitis or some of the exanthemata be established. It is after all in the great field of the preventable diseases of infectious nature that the health officers will do the most work and bear the heaviest responsibilities. Thus while an engineer or a half-trained medical man who has specialized in public health may satisfactorily perform the functions of a health officer in certain particulars it is difficult to see how he can perform the most important. This is a particularly grave problem in maritime cities where the danger of bubonic plague is constantly increasing or where a case of yellow fever may slip in almost any time. It is an important ques-

tion therefore whether the American medical profession shall permit to develop unchallenged that movement now grown so powerful in this country whereby non-medical men are elevated to positions of authority and responsibility in public health matters, which after all are medical matters. Without doubt many non-medical men may become expert health officers and discharge their duties to the communities which they serve in an intelligent manner. Can they be trusted in a crisis however and are we willing as physicians that a practise so fraught with danger be continued?

Finally how can we educate the great mass of people in this country who are engaging in all sorts of philanthropic enterprises which verge on medicine or which require some medical advice and assistance if all this work is to be prosecuted intelligently. These individuals are constantly turning to the medical profession for the solutions of knotty, difficult problems and indeed in no time in the history of this country have physicians had greater opportunities of directing broad, comprehensive charitable movements in the proper direction so that great sums of money shall be intelligently used for useful and beneficial objects. This education of the people in matters affecting their health can probably best be given in a museum of hygiene where models of all sorts of apparatus, collections of charts and statistical materials can be made available for study, where public lectures can be given on health topics, where experts in various lines can be consulted, where commissions can be formed for the investigation of special problems of public health. Such a museum would become a great center for education in hygiene and public health and prove of incalculable benefit to the community in which it might happen to be located.

The question as to which of these three needs should first be satisfied is not easy to answer and the answer will also vary according to the individual point of view of those of us who study the problems. They are here presented in what seems to me to be the logical arrangement. If possible let us first educate our medical students, then our officers of health, then the public. Should the order be changed however no great harm will result. Should this country be so fortunate as to see schools of hygiene attached to the medical departments of our universities properly endowed and aiming to satisfy all three needs, then indeed shall we be fortunate beyond the wildest dreams of the most enthusiastic student of the subject.

WILLIAM W. FORD

THE JOHNS HOPKINS UNIVERSITY

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MEASUREMENTS OF THE DISTANCES OF THE STARS[1]

FOR the lecture in honor and memory of Edward Halley, which it is my privilege to deliver this year, I have chosen an account of the persistent efforts made by astronomers to measure the distances of the fixed stars. For many generations their attempts were unsuccessful, though some of them led to great and unexpected discoveries. It is less than eighty years ago that the distances of two or three of the nearest stars were determined with any certainty. The number was added to, slowly at first, but afterwards at a greater rate, and now that large

[1] The "Halley Lecture" (slightly abridged), delivered at Oxford on May 20, by Sir F. W. Dyson, F.R.S., Astronomer Royal, and printed in the issue of *Nature* for June 3.

telescopes are available and photographic methods have been developed, we may expect that in the next few years very rapid progress will be made.

For many centuries astronomers had speculated on the distances of the stars. The Greeks measured the distance of the moon; they knew that the sun and planets were much further away, and placed them correctly in order of distance, guessing that the sun was nearer than Jupiter because it went round the sky in one year while Jupiter took twelve. The stars, from their absolute constancy of relative position, were rightly judged to be still more distant—but how much more they had no means of telling.

In 1543 Copernicus published "De Revolutionibus Orbium Cœlestium," and showed that the remarkable movements of the planets among the stars were much easier to understand on the hypothesis that the earth moved annually round the sun. Galileo's telescope added such cogent arguments that the Copernican system was firmly established. Among other difficulties which were not cleared up at the time one of the most important was this: If the earth describes a great orbit round the sun, its position changes very greatly. The question was rightly asked: Why do not the nearer stars change their positions relatively to the more distant ones? There was only one answer. Because they are so extremely distant. This was a hard saying, and the only reply which Kepler, who was a convinced believer in the earth's movement round the sun, could make to critics was "Bolus erat devorandus."

Although no differences in the positions of the stars were discernible to the naked eye, it might be that smaller differences existed which could be detected by refined astronomical measurements. To the naked eye a change in the angle between neighboring stars not more than the apparent diameter of the sun or moon should be observable. No such changes are perceived. The stars are—it may be concluded—at least two hundred times as distant as the sun. With the instruments in use in the seventeenth century—before the telescope was used for the accurate measurement of angles—angles one twentieth as large were measurable, and the conclusion was reached that the stars were at least four thousand times as distant as the sun. But no positive results were obtained. Attempts followed with the telescope and were equally unsuccessful. Hooke tried to find changes in the position of the star γ Draconis and failed. Flamsteed, Picard and Cassini made extensive observations to detect changes in the position of the pole star and failed. Horrebow thought he had detected slight changes in the position of Sirius due to its nearness in a series of observations made by Römer. He published a pamphlet, entitled "Copernicus triumphans," in 1727, but the changes in the position of Sirius were not verified by other observers, and were due to slight movements of Römer's instruments.

Thus in Halley's time it was fairly well established that the stars were at least 20,000 or 30,000 times as distant as the sun. Halley did not succeed in finding their range, but he made an important discovery which showed that three of the stars were at sensible distances. In 1718 he contributed to the Royal Society a paper entitled "Considerations of the Change of the Latitude of Some of the Principal Bright Stars." While pursuing researches on another subject, he found that the three bright stars—Aldebaran, Sirius and Arcturus—occupied positions among the other stars differing considerably from those assigned to them in the Almagest of Ptolemy. He showed that the possibility of an error

in the transcription of the manuscript could be safely excluded, and that the southward movement of these stars to the extent of 37′, 42′ and 33′—*i. e.*, angles larger than the apparent diameter of the sun in the sky—were established. He remarks:

> What shall we say then? It is scarce possible that the antients could be deceived in so plain a matter, three observers confirming each other. Again these stars being the most conspicuous in heaven are in all probability nearest to the earth, and if they have any particular motion of their own, it is most likely to be perceived in them, which in so long a time as 1800 years may show itself by an alteration of their places, though it be utterly imperceptible in a single century of years.

This is the first good evidence, *i. e.*, evidence which we now know to be true, that the so-called fixed stars are not fixed relatively to one another. It is the first positive proof that the distances of the stars are sensibly less than infinite. This, then, is the stage at which astronomers had arrived less than two hundred years ago. The stars are at least 20,000 or 30,000 times as distant as the sun, but three of the brightest of them are perceived to be not infinitely distant.

The greatest step in the determination of stellar distances was made by another Oxford astronomer, James Bradley. His unparalleled skill as an astronomer was early recognized by Halley, who tells how

> Dr. Pound and his nephew, Mr. Bradley, did, myself being present, in the last opposition of the sun and Mars this way demonstrate the extreme minuteness of the sun's parallax and that it was not more than 12 seconds nor less than 9 seconds.

Translated from astronomical language, the distance of the sun is between 95 and 125 millions of miles. Actually the distance is 93 million miles. The astronomer who so readily measured the distance of the sun entered on the great research which had baffled his predecessors—the distance of the stars.

The theory of the determination of stellar parallax is very simple: the whole difficulty lies in its execution, because the angles are so small that the slightest errors vitiate the results completely. Even at the present time with large telescopes, and mechanism which moves the telescope so that the diurnal movement of the stars is followed and they appear fixed to the observer in the field of the telescope, and with the additional help of photography, the determination of the parallax of a star requires a a good deal of care, and is a matter of great delicacy. But in Bradley's time telescopes were imperfect, and the mechanism for moving them uniformly to follow the diurnal rotation of the stars had not been devised.

This was in some ways very fortunate, as the method Bradley was forced to adopt led to two most important and unexpected discoveries. Every day, owing to the earth's rotation, the stars appear to describe circles in the sky. They reach the highest point when they cross the meridian or vertical plane running north and south. If we leave out all disturbing causes and suppose the earth's axis is quite fixed in direction, a star S, if at a great distance from the earth, will always cross the meridian at the same point S; but, if it is very near, its movement in the small parallactic ellipse will at one period of the year bring it rather north of its mean position and at the opposite period an equal amount south.

Bradley, therefore, designed an instrument for measuring the angular distance from the zenith, at which a certain star, γ Draconis, crossed the meridian. This instrument is called a zenith sector, and is shown in the slide. The direction of the vertical is given by a plumb-line, and he measured from day to day the angular distance of the star from the direction of the vertical. From December, 1725, to March,

1726, the star gradually moved further south; then it remained stationary for a little time; then moved northwards until, by the middle of June, it was in the same position as in December. It continued to move northwards until the beginning of September, then turned again and reached its old position in December. The movement was very regular and evidently not due to any errors in Bradley's observations. But it was most unexpected. The effect of parallax—which Bradley was looking for—would have brought the star furthest south in December, not in March. The times were all three months wrong. Bradley examined other stars, thinking first that this might be due to a movement of the earth's pole. But this would not explain the phenomena. The true explanation, it is said, although I do not know how truly, occurred to Bradley when he was sailing on the Thames, and noticed that the direction of the wind, as indicated by a vane on the mast-head, varied slightly with the course on which the boat was sailing. An account of the observations in the form of a letter from Bradley to Halley is published in the *Philosophical Transactions* for December, 1728:

> When the year was completed, I began to examine and compare my observations, and having pretty well satisfied myself as to the general laws of the *phenomena*, I then endeavored to find out the cause of them. I was already convinced that the apparent motion of the stars was not owing to a nutation of the earth's axis. The next thing that offered itself, was an alteration in the direction of the plumb-line, with which the instrument was constantly rectified; but this upon trial proved insufficient. Then I considered what refraction might do, but here also nothing satisfactory occurred. At last I conjectured that all the *phenomena* hitherto mentioned, proceeded from the progressive motion of light and the earth's annual motion in its orbit. For I perceived that, if light was propagated in time, the apparent place of a fixed object would not be the same when the eye is at rest, as when it is moving in any other direction, than that of the line passing through the eye and the object; and that, when the eye is moving in different directions, the apparent place of the object would be different.

This wonderful discovery of the aberration of light is usually elucidated by the very homely illustration of how an umbrella is held in a shower of rain. Suppose the rain were falling straight down and a man walking round a circular track: he always holds the umbrella a little in front of him—because when he is walking northward the rain appears to come a little from the north, when he is going eastward it appears to come a little from the east, and so on.

Although the phenomena Bradley had observed were almost wholly explained in this way, there were still some residual changes, which took nineteen years to unravel; and he explained these by a nutation or small oscillation of the earth's axis, which took nineteen years to complete its period. I can not dwell on these two great discoveries. For our present purpose, it should be said that aberration and nutation cause far greater changes in the apparent positions of the stars than, we now know, are caused by parallax. Until they were understood and allowed for or eliminated, all search for parallax must have been in vain. Further, Bradley's observations showed that in the case of γ Draconis, at any rate, parallax did not displace the star by so much as 1.0″ from its mean position, or that the star was 200,000 times as distant as the sun. We may say that Bradley reached to just about the inside limit of the distances of the nearer stars.

Let me now try to give some idea of what is meant by a parallax of 1″, which corresponds to a distance 200,000 times that of the sun. Probably many of you have looked at the second star in the tail of the Great Bear, Mizar, it is named, and have seen

there is a fainter star near it, which you can see nicely on a fine night. These stars are 600″ apart; with a big telescope with a magnification of 600 times—and this is about as high a magnification as can be generally used in England—two stars 1″ apart are seen double just as clearly as Alcor and Mizar are seen with the naked eye. I think this is the most useful way to think of 1″—a very small angle, which one needs a magnification of 600 times to see easily and clearly. Bradley showed that γ Draconis did not wander by this amount from its mean position among the stars in consequence of our changing viewpoint.

The next attempt to which I wish to refer is the one made by Sir William Herschel. In a paper communicated by him to the Royal Society in December, 1781, he reviews the serious difficulties involved in determining the parallax of a star by comparing its zenith distance at different times of the year. Especially there is the uncertainty introduced by the refraction of light, and in addition as the angular distances of stars from the zenith are changed by precession, nutation and aberration, any errors in the calculated amount of these changes will all affect the results. He proposed, therefore, to examine with his big telescope the bright stars and see which of them had faint stars near them. The bright stars, he said, are probably much nearer than the faint stars; and if the parallax does not even amount to 1″ the case is by no means desperate. With a large telescope of very great perfection it should be possible to detect changes in the angular distance of two neighboring stars. By this differential method the difficulties inherent in the method of zenith distances will be eliminated. Herschel made a great survey to find suitable stars, and in this way was led to the discovery of double stars—*i. e.*, of pairs of stars which are physically connected and revolve around one another, just like sun and earth. This was a most important discovery, but as the two components of a double star are practically at the same distance from us they do not serve to determine parallax, for which we need one star to serve as a distant mark.

For another forty years persistent efforts were made without success. Piazzi, in Italy, thought he had detected parallax in Sirius and a number of other bright stars, but the changes he detected in the zenith distances were unquestionably due to errors introduced by uncertainty in refraction, or slight changes in the position of his instruments in the course of the year. Dr. Brinkley, in Dublin, made a gallant effort and took the greatest pains. He thought he had succeeded, and for many years there was a controversy between him and Pond as to whether his results were trustworthy. The state of knowledge of the distances of the fixed stars in 1823 is summed up accurately by Pond in the *Philosophical Transactions:*

> The history of annual parallax appears to me to be this: in proportion as instruments have been imperfect in their construction, they have misled observers into the belief of the existence of sensible parallax. This has happened in Italy to astronomers of the very first reputation. The Dublin instrument is superior to any of a similar construction on the continent; and accordingly it shows a much less parallax than the Italian astronomers imagined they had detected. Conceiving that I have established, beyond a doubt, that the Greenwich instrument approaches still nearer to perfection, I can come to no other conclusion than that this is the reason why it discovers no parallax at all.

Besides these and other efforts to find parallax in the zenith distances of stars, attempts were also made to detect changes in the time at which the stars cross the meridian, to see if they are slightly before their time at one period of the year and slightly after it at another. But these, too,

were unsuccessful, even in the hands of astronomers like Bessel and Struve. The best were some observations of circumpolar stars made by Struve in Dorpat between 1814 and 1821. The following table shows some of the results at which he arrived:

Polaris and ϵ Urs. Maj.	$\pi + 0.053\pi' = +0.''075 \pm 0.''034$
ϵ Urs. Maj. and α Cass.	$\pi + 0.962\pi' = -0.136 \pm 0.110$
ζ Urs. Maj. and δ Cass.	$\pi + 1.099\pi' = +0.175 \pm 0.127$
β Urs. Min. and α Persei	$\pi + 0.402\pi' = +0.305 \pm 0.071$
Capella and β Drac.	$\pi + 1.147\pi' = +0.134 \pm 0.139$
β Aurig. and γ Drac.	$\pi + 1.138\pi' = +0.020 \pm 0.117$

This table has the merit of not looking wildly impossible in the present state of our knowledge. It has the disadvantage of not giving a definite parallax to each star. For example, it is impossible to say how much of the 0.134″ is to be given to Capella and how much to β Draconis. Further, the probable errors, though really small, are nearly as large as the quantities determined.

Struve and Bessel therefore attempted the problem by the differential method recommended by Herschel. By this time it had become easier to carry out. The method of mounting telescopes equatorially had been devised, so that the telescope was always kept pointing to the same part of the sky by clockwork-driven mechanism. Struve chose the bright star α Lyræ, and measured its distance from a faint star about 40″ away on ninety-six nights between November, 1835, and August, 1838. In the focal plane of his telescope he had what is called a position micrometer. The micrometer contains two parallel spider-threads stretched on frames, and the frames are movable by screws until the position shown in the diagram is reached: the distance apart of the threads is known by the readings of the screw-heads. He found that α Lyræ had a parallax 0.262″ with a probable error $\pm$ 0.025″.

Bessel chose the star 61 Cygni as a likely star to be near the sun, and therefore to have appreciable parallax. 61 Cygni is not nearly so bright as α Lyræ, but has a very great angular movement or proper-motion among the stars. Bessel used an instrument called a heliometer. Like Struve's telescope, it was mounted so that it could be driven by clockwork to point always at the same star. The object-glass of Bessel's telescope was made by the great optician Fraunhofer, with the intention of cutting it in halves. Fraunhofer died before the time came to carry out this delicate operation, but it was successfully accomplished after his death.

Delicate mechanism was provided for turning the glass, and also for moving the two halves, the amount of movement being very accurately measured by screws. Each half gives a perfect image of any object which is examined, but the two images are shifted by an amount equal to the distance one-half of the lens is moved along the other. Thus when a bright star and faint star are looked at, one half of the object-glass can be made to give images S and s, and the other half S′ and s'. By moving the screw exactly the right amount s' can be made to coincide with S, and the reading of the screw gives a measure of the angular distance between the two stars. Bessel made observations on ninety-eight nights extending from August, 1837, to September, 1838. The table, taken from a report by Main,[2] shows how closely the mean of the observations for each month accords with the supposition that the star has the parallax 0.369″:

[2] *Mem. R. A. S.*, Vol. XII., p. 29.

1837

Mean Date	Observed Disappointment	Effect of Parallax 0″369
August 23	+ 0″.197	+ 0″.212
September 14	+ 0.100	+ 0.100
October 12	+ 0.040	— 0.057
November 22	— 0.214	— 0.258
December 21	— 0.322	— 0.317

1838

Mean Date	Observed Disappointment	Effect of Parallax 0″369
January 14	— 0″.376	— 0″.318
February 5	— 0.223	— 0.266
May 14	+ 0.245	+ 0.238
June 19	+ 0.360	+ 0.332
July 13	+ 0.216	+ 0.332
August 19	+ 0.151	+ 0.227
September 19	+ 0.040	+ 0.073

Simultaneously with these determinations of the distance of α Lyræ and 61 Cygni, the distance of α Centauri, one of the brightest of the southern stars, was found by Henderson from observations of zenith distance made by him at the Cape between April, 1832, and May, 1833. He learned just before the termination of his residence at the Cape that this star had a very large proper-motion. Suspecting a possible parallax, he examined the observations when he had taken up his new office of Astronomer Royal for Scotland, and found a parallax amounting to 0.92″. He did not, however, publish his results until he found that they were confirmed by the right ascensions. In a communication to the Royal Astronomical Society in December, 1838, he states that it is probable that the star has a parallax of 1.0″.

The great and difficult problem which had occupied astronomers for many generations was thus solved for three separate stars in 1838 (see table).

Henderson's observation is interesting because α Centauri is, as far as we yet know, the nearest of all the stars to us. But by far the most valuable of these observations is Bessel's. The heliometer, which he devised, proved itself to be by far the most serviceable instrument for determining stellar parallax until the application of photography for this purpose.

	Parallax	Distance	Modern Observations: Parallax	Modern Observations: Distance
α Centauri (Henderson)	1″.0	200,000	0″.750	270,000
61 Cygni (Bessel)	0.314	640,000	0.285	700,000
α Lyræ (Struve)	0.262	760,000	0.10	2,000,000

(The unit of distance is that from the earth to the sun.)

The somewhat dramatic manner in which the distances of three stars were determined in the same year, after several centuries of failures, may have led to the hope that the range of many more stars would soon be found. This was not the case, however. Each star had to be measured separately, and involved many nights of observations. The quantities to be measured were so small that they taxed the resources of the best instruments and best observers. In 1843 Peters published the parallaxes of half a dozen stars determined with the vertical circle at Pulkova, but the parallax of only one of these, Polaris, is obtained with much accuracy. With Bessel's heliometer, Schlüter and Wichmann measured the distance of Gr. 1830, the star which had the largest known proper-motion. In the 'sixties, Auwers with the same instrument determined the parallax of several quick-moving stars, and also of the bright star Procyon. With the Bonn heliometer, Krueger in the 'sixties measured the distance of three stars, and Winnecke two more. Other observations were made, amongst others, by Maclear, Otto Struve, Brünnow and Ball; but as these observers had not such suitable instruments, their results were not of the same high standard of value. A generous estimate would place the number of stars the distance of which had been satisfactor-

ily determined before 1880 at not more than twenty.

In the 'eighties, progress became more rapid. Gill, the Astronomer Royal for the Cape, in conjunction with a young American astronomer, Elkin, determined with great accuracy, though with only a small 4-inch heliometer, the distance of nine stars of the southern hemisphere. These stars included α Centauri, and the bright stars Sirius and Canopus. These results were communicated to the Royal Astronomical Society in 1884. The work of Gill and Elkin did not stop there. After some years, a very fine 7-inch heliometer was obtained at the Cape, and with it, between 1888 and 1898, the parallaxes of seventeen stars were determined by Gill and his assistants with very great accuracy. The stars observed at the Cape consisted of the brightest stars of the southern hemisphere, and of the stars with the greatest proper-motions. The results were remarkable. The stars with large proper-motions were nearly always comparatively near—say within one million times the sun's distance. On the other hand, some of the very brightest stars, particularly Canopus, the brightest star in the sky after Sirius, were at vastly greater distances.

Meanwhile Elkin, who had been appointed director of the Yale Observatory in 1884, carried out with a 6-inch heliometer, between the years 1885 and 1892, a determination of the distances of the ten brightest stars of the northern hemisphere. After these were finished the Yale observers, Elkin, Chase and Smith, embarked on the ambitious program of the determination of the distances of 163 stars of the northern hemisphere which show large proper-motion. They have added forty-one southern stars to these, and thirty-five stars of special interest. The results of all these observations were published in 1912. They have not, in most cases, the high accuracy of the Cape observations, but, nevertheless, are of great accuracy, and appear to be free from any considerable systematic error. A third important series of observations was made by Peter with a 6-inch heliometer at Leipzig. These were commenced about 1890, and continued until the death of Professor Peter in 1911. The parallaxes of twenty stars were determined with the same high accuracy as the Cape observations.

Observations with the heliometer require both skill and industry. To secure the needful accuracy measures must be made in four different positions of the instrument, so that possible small systematic errors may be eliminated by reversal. Great care is required in the adjustments of the instrument, particularly in the accurate determination of the scale-value at different temperatures. The possibility of obtaining satisfactory results with less labor was considered by Kapteyn, in view of the successful determination of the parallax of Gr. 34 by Auwers. From 1885 to 1887 he made observations with the transit-circle at Leyden of fifteen stars for the purposes of determining parallax. The observation consisted in observing the time when the star the parallax of which was sought and two or three neighboring stars crossed the meridian. Observations are made at the two most favorable epochs—say every night in March, and every night in September—to determine whether the star has changed its position relatively to its neighbors in the interval. The difficulties are twofold. The purely accidental error of observations of transits is considerable as compared with the small quantity which is sought. Besides this, the star of which the parallax is required is probably brighter than the comparison stars, and special precautions are required to guard against personal errors of the observer.

In questions of this kind the only satisfactory way is to judge by the results. From observations made on fifty nights, values of the parallax are obtained not nearly so accurate as the best heliometer observations, but still of considerable accuracy. Finally, the parallaxes of four of the stars which had been previously determined by measures with a heliometer showed satisfactory agreement.

This method has been employed by Jöst at Heidelberg, very extensively by Flint at the Washburn Observatory of the University of Wisconsin, and is now being tried at the Cape by Vouté, a pupil of Kapteyn's. It appears to me that this method can never give results of the highest accuracy, but that it may be of use in a preliminary search for stars of large parallax. The argument of the facility of the method compared with the heliometer has, however, lost much of its force; for, as I hope to show next, the highest accuracy attainable with the heliometer can be secured much more easily with a photographic telescope.

The application of photography to the determination of stellar parallax was first made by Pritchard in Oxford between 1887 and 1889. He took a large number of photographs and measured on them the angular distance of the star which he was considering from four of its neighbors. In this way he determined the parallax of five stars. He began this work late in life, and it was left for others to develop the photographic method and find what accuracy could be attained with it. At first sight it seems very easy, but experience shows that there are a number of small errors which can creep in and vitiate the results, unless care is taken to avoid them.

It has gradually become clear that with a few simple precautions and contrivances, a greater accuracy can be reached in the determination of parallax by photography and with much less trouble than by any other method. Between 1895 and 1905, several astronomers succeeded in obtaining from a few plates results as accurate as could be obtained from many nights' observations with the heliometer by the most skilled observers. In the last five years a large number of determinations have been made. In 1910 Schlesinger published the parallaxes of twenty-five stars from photographs taken with the 40-inch refractor of the Yerkes Observatory, and in 1911 Russell published the parallaxes of forty stars from photographs taken by Hinks and himself at Cambridge. The opinion expressed by Gill on these observations[3] was that but for the wonderful precision of the Yerkes observations, the Cambridge results would have been regarded as of the highest class. The facility with which the Yerkes results are obtainable is expressed very tersely by Schlesinger:

> The number of stellar parallaxes that can be determined per annum will in the long run be about equal to the number of clear nights available for the work.

With the heliometer at least ten times as much time would have been required. During the last year two further installments of the results of the Yerkes Observatory have been published by Slocum and Mitchell, giving the parallaxes of more than fifty stars. It might be thought that the high accuracy attained by them is largely attributable to the great length of the telescope. From experience at Greenwich, I do not think this is the case, and believe that similar results are obtainable with telescopes of shorter focal length. As several observatories are now occupied with this work, we may expect that the number of stars the distances of which are fairly well known will soon amount to thousands, as

[3] *M. N.*, Vol. LXII., p. 325.

compared with three in 1838, about twenty in 1880, about sixty in 1900, and now perhaps two hundred.

The stars the distances of which have been measured have generally been specially selected on account of their brightness or large proper-motion. Each star has been examined individually. Kapteyn has suggested that instead of examining stars singly in this way, photography gives an opportunity of examining all the stars in a small area of the sky simultaneously, and picking out the near ones. The method has been tried by Kapteyn and others—among them Dr. Rambaut. The idea is very attractive, because it examines the average star and not the bright star or star of larger proper-motion. It is liable, however, to some errors of systematic character, especially as regards stars of different magnitudes. Comparison of the results so obtained with those found otherwise will demonstrate whether these errors can be kept sufficiently small by great care in taking the photographs. Until this is done no opinion can be expressed on the success of this experiment, which is worth careful trial.

The question may be asked, How near must a star be to us for its distance to be measurable? I think we may say ten million times the sun's distance. This corresponds to the small angle 0.02″ for the parallax. If a star's parallax amounts to this, there are, I believe, several observatories where it could be detected with reasonable security, though we shall know more certainly by the comparison of the results of different observations when they accumulate.

You will readily imagine that an accurate knowledge of the distances of many stars will be of great service to astronomy. There are ample data to determine the positions, velocities, luminosities and masses of many stars if only the distances can be found. Thus we know the distance of Sirius, and we are able to say that it is travelling in a certain direction with a velocity of so many miles per second; that it gives out forty-eight times as much light as the sun, but is only two and a half times as massive. The collection and classification of particulars of this kind is certain to give many interesting and perhaps surprising results. But it is not my purpose to deal with this to-night. The task I set before myself in this lecture was to give an idea of the difficulties which astronomers have gradually surmounted, and the extent to which they have succeeded in measuring the distances of the stars.

F. W. Dyson

SCIENTIFIC NOTES AND NEWS

Fifty years ago William North Rice was graduated from Wesleyan University, and two years later was elected professor of geology and natural history, a title which was changed to professor of geology in 1884, when the department of biology was established. Professor Rice's services as teacher, administrator and investigator were acknowledged by the conferring on him of the degree of doctor of laws by Wesleyan University at its recent commencement.

Dr. Victor C. Vaughan, professor of hygiene at the University of Michigan and president of the American Medical Association, received the honorary degree of LL.D. at the annual commencement of Jefferson Medical College, Philadelphia, on June 5.

Three doctorates of science were conferred by the University of Pennsylvania at its commencement exercises on June 16. The recipients and Provost Smith's remarks were as follows: *Robert Andrews Millikan*—Physicist of eminence, editor, whose investigations in electricity, in molecular physics and heat have won for you deserved and well-merited recognition. *Harry Frederick Keller*—Because of your profound knowledge of chemical science,

because of your acknowledged thoroughness in the teaching of the same, because of your happy solution of perplexing and important problems in inorganic and synthetic organic chemistry. *Arthur Newell Talbot*—Master of engineering in its relations to railway, hydraulic and sanitary construction, eminent as a teacher of theoretical and applied mechanics, prolific and respected writer on these subjects.

YALE UNIVERSITY has conferred its doctorate of science on Dr. Ch. Wardell Stiles. In presenting the degree Professor Woolsey said: "Charles Wardell Stiles, zoologist—Five years of foreign study, arduous research and the spur of visible suffering have fitted and impelled Dr. Stiles to attack the obscurities of parasitic disease. Both brutes and men owe him gratitude. He is the discoverer of the American hookworm, that widespread and dreadful scourge of the south. By his investigation and through his propaganda an entire people is being lifted to a higher plane of physical and economic being."

DR. DAVID WHITE, of the U. S. Geological Survey, has been elected a corresponding fellow of the Royal Society of Canada.

THE Osiris prize of $20,000, which the Institute of France gives every three years for the most remarkable work in science, art, letters or industry, was awarded on June 2 jointly to Professors Widal and Chantemesse and Dr. Vincent, of the University of Paris, for their work in the development of anti-typhoid vaccination. As this prize can only be given to Frenchmen, the institute has awarded a special prize to Sir Almroth Wright, for his discovery of this means of protection from typhoid.

TEN Philadelphia surgeons and four nurses sailed from New York on the steamship *St. Louis*, on June 12, for the war zone in France. They will have charge of a floor in the American Ambulance Hospital, and will make an exhaustive study of the treatment of wounded soldiers. The Philadelphia doctors, most of whom are making the trip at their own expense, will have charge of about 200 wounded men. Of the general expenses about $7,000 of the $10,000 needed has been subscribed. The unit will be abroad three months. Dr. J. William White, emeritus professor of surgery at the University of Pennsylvania, is in charge of the party. Besides Dr. White, the members of the party on the *St. Louis* are Dr. James P. Hutchinson, who will be the managing head of the unit; Dr. Daniel J. McCarthy, neurologist; Dr. Edmund B. Piper; Dr. Walter Estell Lee; Dr. Arthur E. Billings; Dr. Peter M. Keating; Dr. Samuel Goldschmidt, bacteriologist; Dr. Thomas C. Aller and Dr. David M. Davis, of Johns Hopkins University.

DR. CLIFFORD RICHARDSON, of New York, was elected president of the Association of Harvard Chemists at the fourth annual dinner, held recently, at Young's Hotel, Boston. Other officers are: *Vice-presidents,* Professor W. D. Bancroft, of Cornell University, and Dr. F. W. Clark, of Washington; *Secretary and Treasurer,* Professor S. B. Forbes. About thirty-five members were present with these speakers: Professors T. W. Richards and G. P. Baxter, of Harvard University, and George B. Leighton, of Boston.

MR. N. G. NELSON, of the department of anthropology of the American Museum of Natural History, is engaged in excavating the prehistoric and early historic ruined villages in the neighborhood of Santa Fé. Dr. Robert H. Lowie has left for field work among the Kiowa Indians of Oklahoma, the Hopi of Arizona and the Painte of Nevada.

GEORGE B. ROORBACH, instructor of geography in the Wharton School, University of Pennsylvania, has received an appointment from the Carnegie Endowment for the Advancement of International Peace to carry on investigations this summer in Venezuela on the effect of the war on industrial, commercial and financial conditions in that country. Mr. Roorbach sailed for Venezuela June 16, to be gone during the vacation.

MR. FRANK COLLINS BAKER has resigned his position as acting director and curator of the Chicago Academy of Sciences. Mr. Baker has held the office of curator for twenty-one years, during which time he has built up large study collections, many of which have formed the basis for extensive monographs. The

unique natural history survey of the Chicago area, first organized by Dr. W. K. Higby (now deceased), who for many years was secretary of the academy, was largely carried on by Mr. Baker; the educational installations in the museum of the academy were also prepared under his direction. His address for the summer will be 1555 Highland Avenue, Rochester, N. Y.

The Croonian lectures before the Royal College of Physicians of London were announced to be delivered on June 17, 22, 24 and 29, by Surgeon General Sir David Bruce, C.B., F.R.S. The subject of the lectures was "Trypanosomes Causing Disease in Man and Domestic Animals in Central Africa."

Dr. Shipley, master of Christ's College, Cambridge, gave a lecture for the National Health Society, on flies, lice and minor horrors of war, at the house of the Royal Society of Medicine, on June 16.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. Barton A. Hepburn, of New York, is to present to Middlebury College a men's dormitory costing nearly $200,000. Mr. Hepburn received his degree of A.B. at Middlebury. The building, on which work is to be started at once, will be five stories of marble or granite, in keeping with the other college buildings.

The Massachusetts Agricultural College has recently received $4,000 by the will of Major Henry E. Alvord, formerly chief of the dairy division of the Department of Agriculture.

The late Dr. W. Aldis Wright, vice-master of Trinity College, has bequeathed the sum of £5,000 for the use of the library of the University of Cambridge.

Dr. Ruby Cunningham has been appointed instructor in hygiene and an infirmary physician in the infirmary of the University of California.

Raymond B. Robbins, Ph.D., has been appointed instructor in mathematics in the Sheffield Scientific School, Yale University.

At Western Reserve University new appointments have been made as follows: Arthur Dunn Pitcher, Ph.D., professor of mathematics; Jesse E. Hyde, A.M., associate professor of geology; John M. Stetson, Ph.D., instructor in mathematics; William Henry Weston, Jr., A.M., instructor in biology.

DISCUSSION AND CORRESPONDENCE

EDITORIAL SUPERVISION FOR EXPERIMENT STATION PUBLICATIONS

The *Experiment Station Record* for April, 1914, contains a pertinent plea for the need of judicious criticism of agricultural experimentation. The following is written in order to direct special attention to this need in experiment-station publications. It is furthermore desired to suggest that the general adoption of certain policies now employed in many of the experiment stations would eliminate from publications such glaring features as poor English and poor literary style, loose and inexact statements, improper use of technical terms, failure to recognize the existence of published works of a similar nature or the bearing of the results secured upon related fields of science, drawing conclusions not warranted by the data in hand, and the publication of superficial or inconclusive work. One needs only to consult the recent publications in order to convince himself that all of these offences have been committed and it is logical to suppose that they will continue to be committed unless measures for their prevention are put into operation.

The following quotations, taken at random from scores of their kind, will suffice to illustrate the need of criticism. "The fungus was run on artificial media," "The appressoria were round, black bodies, from an eighth to a quarter inch in diameter," "Infection experiments were tried with cultures in the open and in the greenhouse," "Infected plants can be distinguished by a thin growth," "They (pycnidia) are hollow within," "No peas have been reported to be attacked by the eel worm out of doors." These statements have been chosen only because of my better famil-

iarity with botanical literature than with other fields of work, and it is not to be presumed that botanists alone among the staffs of experiment stations have offended science and the Queen's English. It is felt that the inclusion, in circulars and bulletins, of statements of this sort is due entirely to a lack of criticism in the preparation of manuscripts. It is perhaps not fully realized that publications are permanent records which are to be regarded as the product of the institution as well as of the author, and that the character of the publication, for which the several officers of the station are jointly responsible, therefore reflects their joint ability.

In order to learn how much editorial and censorial supervision manuscripts receive and to what extent the individual members of the station staffs are actually responsible for the character of the publications, a questionnaire was sent to the director of each of the agricultural experiment stations. Forty-six replies were received. Five of these report that a special officer, known as publicist or editor, censors all manuscripts submitted for publication with respect both to form and to content, and that he, together with the directors, has the power to withhold or to reject any manuscripts submitted. In eighteen of the stations the director alone exercises this censorship. In twenty-three the manuscripts for all bulletins and circulars are submitted to an editorial committee. This committee is variously constituted but in conjunction with the director it exercises all the powers and prerogatives of a board of editors. Certain stations have a standing committee who edit all manuscripts, and others a special committee whose personnel consists of those officers most interested in the particular subject concerning which a publication is desired.

It is realized, of course, that there is a greater complexity of organization in the larger experiment stations than in the smaller. It might be granted too that there is a greater need for the organization of editorial committees in the larger institutions with their greater number of projects for investigation and consequently their greater number of publications. Naturally the officers in the several different departments will be less closely associated with each other and consequently less familiar with the nature of the various problems under investigation in the larger stations.

There are those, not in every station perhaps, who, through lack of ability to express themselves or through lack of training and experience in their own or related fields, would be spared the caustic criticism of their colleagues and of the reading public if their manuscripts had been subjected both to a constructive and to a destructive criticism prior to publication. Too much emphasis can not be placed on the fact that much of the value of a piece of work is lost if it is not carefully written both with respect to syntax and to the employment of such words as convey the author's intended shades and tints of meaning. One does not credit experimentation which is inaccurately reported. It only reflects discredit on the institution, on the author, and on the other members of the station staff. Experiment station publications can not attain the high standard of merit maintained by the scientific journals until a means is provided to secure adequate, critical, editorial supervision of all manuscripts.

FREDERICK A. WOLF
ALABAMA POLYTECHNIC INSTITUTE,
AUBURN, ALA.

A SIMPLE TECHNIQUE FOR THE BACTERIOLOGICAL EXAMINATION OF SHELL EGGS

THE eggs are first immersed in a strong soap solution (the standard soap solution used in water analysis has been found to be very satisfactory) and scrubbed with a small brush to remove any adherent dirt and hen feces; then they are thoroughly dried in a clean towel and immersed in a mercuric chloride solution (1:1,000) and allowed to remain about five minutes.

The egg is now removed from the mercuric chloride solution, care being taken to handle it by the small end, and without drying it is put into 60–70 per cent. alcohol, where it is allowed to remain a few minutes.

Again handling the egg by the small end it is placed upon a three-inch clay triangle (which

has been previously flamed to insure sterility) large end down and the alcohol ignited by quickly passing a flame under the egg. The success of the method from this point on depends upon the formation of a drop of water from the alcohol (60–70 per cent. alcohol has been found most satisfactory) on the bottom (large end) of the egg.

When the alcohol has burned off, a very hot flame (Tirrell burner) is directed at the drop of water on the under side of the egg and after sufficient heating a piece of the egg shell from 1 to 2 cm. in diameter snaps off. In some cases the vitelline membrane is broken at this point and the contents of the egg run out, so it is necessary to have a container ready for use.

If the vitelline membrane does not break at this point or all the contents do not run out, it is only necessary to apply the flame gently to the top (small) end of the egg when the expansion of the air will totally empty the shell. Care must be taken at this point not to burn the egg shell or coagulate the contents. This heating should be done with a nearly luminous flame.

The most satisfactory type of receiver is a large Phillips beaker which has been previously sterilized with a sufficient quantity of broken glass in it to cover the bottom of the flask. This broken glass serves to cut up both the yolk and white and make a homogeneous mixture from which an average sample can be withdrawn and plated, using the usual precautions.

This method has the following advantages:

1. Simplicity. It eliminates the sterilization of instruments in opening the egg and simplifies the operation of breaking the shell.

2. It eliminates the chances of introducing foreign chemicals, which have been used for sterilizing the instruments for breaking the shell, into the egg.

3. It minimizes the chances of infecting the egg during opening and consequently allows of a more accurate determination of the bacterial count of the content.

J. E. Rush

Department of Biology,
Carnegie Institute of Technology

QUOTATIONS

THE DISMISSAL OF PROFESSOR NEARING

The issue which the trustees of the university of Pennsylvania have raised by their summary action in dispensing with the services of one of the most able and efficient professors of the Wharton School faculty is vastly more important than any considerations whatever affecting the personality or opinions of the teacher in question or of the members of the board itself. It is because the incident reveals the existence of an irrepressible conflict between two widely differing ideals of university responsibility and duties that it has called forth an instant and widespread protest. The *New Republic* recently defined this conflict as one "between political reaction and political progress, between intellectual repression and freedom of speech, between a plutocracy strongly intrenched and a democracy not yet fully conscious of itself." And the arguments that have been already volunteered in defense of the trustees, albeit they are themselves silent as to the reasons for their unusual action, fully justify the assumption expressed in every protest that the trustees ("the people who raise the money") regard "the expression of economic discontent as immoral," and are determined to penalize instead of encourage, on the part of the teaching staff, that "continual and fearless sifting and winnowing by which alone the truth can be found.

One of the trustees, however, has modified the issue, if he has not raised an entirely new one, when he denied the right of the public or the alumni to demand any explanation of the governing body of the university. "No one has the right to question us" he is reported to have said. "The University of Pennsylvania is not a public institution. It is only quasi-public. We are answerable only to our own sense of duty and responsibility." This is true only in the most narrow and technical sense, and it is certainly not the position taken by the trustees when they approach the city and state for legislative favors and for grants

in aid from the public treasury. But even were it literally true, the public would still have a right to know something about the policy of a great institution, chartered by the state, which performs so vitally important a function in the formation of public opinion and in the creation of an intelligent understanding among the people of the problems of science and government. They have the right to inquire as to motives and actions of those who presume to limit the boundaries of research, to define what is and what is not truth, and to put the brand of uniformity upon the teaching body.

There is something peculiarly Prussian in the assumption that because Mr. A., representing great corporation interests, and Mr. B., appointed to the board by reason of his wealth and his willingness to invest it in university buildings and endowments, have thereby acquired a vested right to design and apply their own peculiar brand of orthodoxy to the teaching of an institution which proclaims in its motto that "culture without character is vain." What sort of "character" will be imposed upon the student body by teachers compelled under threat of summary dismissal to take an oath of conformity to the views of men who can not bear to hear a frank discussion of political, social or economic reform? The public has every right to know whether its greatest teaching institution is free to seek the truth and to proclaim it without fear, or whether it is compelled to suppress every opinion on economics or politics that is for the moment distasteful to trustees whose sole responsibility is discharged when they appoint able and fearless men to its faculties and attend to the business details of university management.—The Philadelphia *Public Ledger.*

SCIENTIFIC BOOKS

Nature and Science on the Pacific Coast. A Guidebook for Scientific Travelers in the West. Edited under the auspices of the Pacific Coast Committee of the American Association for the Advancement of Science. Paul Elder & Co., San Francisco. 1915.

This is a happily conceived and creditably executed enterprise by the Pacific Coast Committee of the American Association for the Advancement of Science. Its many chapters, individually and severally, are chart and compass to the natural attractions and scientific wealth of the west coast and will make an effective guide to the traveler of this and future years. All the world is on the way to the Fair, and it is certainly appropriate that the organized body of scientific men of the west have joined hands in preparing this useful and attractive exposition of what that part of the country is prepared to and does contribute to the scientific treasury of the world.

Probably the old-time breed of eastern folk who entertained the notion that the Pacific ocean washes the western foot of the Alleghany Mountains is now pretty nearly extinct, but there is still something of this psychological attitude in the east toward the west which needs the infusion of just such a serum as a book of this kind, presented in inviting form and popular dress, may produce. Dwellers in Manhattan say they can identify a Brooklynite by his psychology; likewise the dwellers in the east have been wont to look upon the great propositions of the west as not seriously entering into their lives. This is merely by way of expressing an inherited mental attitude. Tides and winds, ocean currents and climate zones, different fauna and other flora, newer mountains, younger rocks, unlike opportunities for economic development, and dissimilar production, all certainly do tend to make the Pacific states unlike, in natural factors and product, to those of the east. As woman can not be expressed in terms of man, so the west can never become fully comprehensible in terms of the east; but the readjustments in ideals and idolatry which invasion of the west by the east requires, are essential to the making of the full-fledged American.

So the present occasion affords every excuse for such an authorized production of these chapters on the natural aspect of the Pacific coast, all of them prepared by men

whose names and activities are familiar and impressive. The worth of the chapters can in no wise be measured by the fugitive character of the occasion that has brought them into existence. The fairs will soon be over and we may hope that before long the great world will again be opened to the traveler, but the scientific men of the west have erected a monument here which will serve not alone as a present guide to the coast but will retain its worth even while its own trees of knowledge continue to bear more fruit.

The scope of the book is rather extraordinary. Dedicated to the late John Muir, it seems, as one might say, to cover every theme into which that genius of the west came into active contact. The chapters begin with a historical approach to the country, touching upon the Spanish occupation; then passing through the meteorology and physiography, reach the solid foundations in a series of important essays on the geological features. The foundations being thus laid, biological chapters follow, the flora and fauna of land and sea being taken up, each after its kind; then ethnology and the skies which bend themselves about the Pacific coast to give it its cosmic individuality. In the sequence come the practical applications of these scientific factors, in agriculture, in irrigation, in chemistry; much on the out-of-doors, something on the literature, a little on the special mode of juridical and political development, and, in fine, a chapter on things to see and how to see them.

The chapters of this book can, of course, be referred to only in the briefest way in a notice of this kind, but it may be said that the text throughout is supplemented with effective half tones and useful maps, 29 of the former and 14 of the latter, in addition to which is a considerable number of text diagrams and sketches. The maps are, for the most part, of the greater cities and their vicinity, but there are double-sheet maps, one of the geology of the west coast and one of the life zones of California.

I. *The Approaches to the Pacific Coast. By Frederick J. Teggart.*—The early outpourings of Asia; the advance of Spain from the victorious armies of Cortes at the south; the individual initiative of the English explorer coming through from the north; the persistent endurance and final triumph of generations of frontiersmen pressing overland in defiance of natural barriers, constitute a romantic adventure in settlement which, somehow, seems to laugh at "gateways" and "geographic control" and to trifle with some of the most sacred dogmas of "human geography."

II. *Spanish Settlements on the Pacific Coast. By Charles E. Chapman.*—A valuable record of the Spanish occupation and of the Mission Fathers—"California under Spain, beside which Acadia and Utopia were unattractive, a dream life for over half a century." With a map locating the missions, pueblos and presidios of California.

III. *Historical Sketch of the Panama Canal. By Rudolph J. Taussig.*—For the contemporary reader somewhat gorged with recent history of the canal, the early dreams of the "Secret of the Strait" and the birth of the idea of the Canal, "which is almost as old as the discovery of America itself," will present a singular attraction.

IV. *Weather Conditions on the Pacific Coast. By Alexander McAdie.*—Premising that we know little of the causes of "weather" anywhere, the accomplished author of this chapter explains how very much that little is by a series of temperature charts and statistical records of weather variations, sunshine, wind, fog, rainfall, etc. Some interesting statements are found in these paragraphs, interesting at least to those who have become used to the glowing réclamé of California weather. "The amount of sunshine received at San Francisco is not as large as might be expected, but nevertheless compares favorably with that of other cities of the United States." "One of the most marked climatic features of San Francisco is the prevalence of fog. . . . the summer afternoon sea fog shuts out 50 per cent. or more of the possible sunshine between 3 and 7 P.M. during June, July and August." "In addition to the summer after-

noon sea fog moving from west to east and the land or tule fog of winter mornings, there is a third kind of fog which may be called smoke fog. Under certain atmospheric conditions the smoke of the city moves seaward during the forenoon and returns about 1 P.M. as a dense black pall."

V. *Physiographic Geography. By Ruliff S. Holway.*—Outlines the remarkable contrasts in the upstanding geologic expressions of the coast.

VI. *Geology of the West Coast Region of the United States. By C. F. Tolman, Jr.*—A summary of the results of an army of workers in this field; outlining the geologic succession up to the Cordilleran Revolution, giving its history since, a correlation table of the entire rock column, a summary of the mineral production and a *vade mecum* to the principal mining districts of California.

VII. *Earthquakes. By J. C. Branner.*—A succinct statement of seismological principles and factors, covering an actual two and one half out of a possible three hundred and two pages; an obviously inverse proportion. Pneumatologically and strategically the gem of the collection.

VIII. *Mines and Mining. By H. Foster Bain.*

IX. *Petroleum Resources and Industries of the Pacific Coast. By Ralph Arnold.*—Further and more detailed statements of production of the basic minerals with which the west coast enters the market. California, no longer first in gold production, is now first in the production of petroleum, and perhaps no feature in the development of the mineral industry of America has been so extraordinary as the California output of oil. Notice is taken of the various oil districts and the fundamental relation of oil storage to monocline structures. Referring to the origin of the oils, the following paragraph is an excellent contemporary expression:

"The oils of the California fields are believed to have been derived largely from the organic shales which are associated with the oil-bearing beds in all fields of the state. It is believed that the oil originated from the organic matter, both vegetable and animal, which is contained in these beds. Probably the principal source of the oil has been the diatomaceous deposits which make up a large percentage of the Tejon or Eocene formation in the Coalinga district and the Monterey or Lower Miocene formation throughout the balance of the districts. Other organisms that may also be the source of some of the oil are plants, Foraminifera, Bryozoa and possibly mollusks and fish. A great deal of evidence can be advanced favoring the organic origin of the oil in California and enough demonstrating the impossibility of its inorganic origin locally to practically prove the former theory by the process of elimination."

It seems rather appropriate that, in connection with this very positive expression, the author has inserted in his chapter, on the reverse side of a plate showing the oil derricks in Santa Barbara county, a picture of a group of trilobites and other oleaginous Cambrian crustaceans collected by Mr. Walcott at Mt. Wapta, British Columbia.

X. *Significant Features in the History of Life on the Pacific Coast. By John C. Merriam.*—Paleontologic science on the west coast has had remarkable development in late years, and aside from the well-known discoveries from the older rocks, the life records of the Pleistocene caves and of the asphalt pool of Rancho La Brea are among the amazing things of the earth. Of the latter Doctor Merriam says: "Literally hundreds of thousands of specimens have been obtained from these deposits," and the victims of these tar-traps are of considerably more than 100 species, from saber-toothed tigers to thousand-legged worms. Such a snare as this indicates most impressively what tremendous faunas have roamed the earth and air in past ages and have escaped untrapped.

XI. *The Vertebrate Fauna of the Pacific Coast. By Joseph Grinnell.*

XII. *Fishes of the Pacific Coast. By David Starr Jordan.*—Exceedingly interesting résumés, the latter with much useful data regarding the fisheries production.

XIII. *Marine Biology of the Pacific Coast.*

By Charles Atwood Kofoid.—This presents the invertebrate life, gives some account of the aquaria and research stations along the coast, notes the collecting grounds, takes special note of that characteristic Californian, the Abalone, and of the seals, sea lions and whales of these waters.

XIV. *Oceanic Circulation and Temperature off the Pacific Coast. By George F. McEwen.*—An empirical and theoretical consideration of the causes of present oceanic circulation on the west coast.

XV. *Insects of the Pacific Coast. By Vernon Kellogg.*—A very inviting chapter, as far as it goes, closing with the equivocal remark: "The Pacific coast will match its insects against the equivalent fauna of any other region."

XVI. *Flora of the Pacific Coast. By Harvey Monroe Hall.*

XVII. *Forests of the Pacific Coast. By Willis Linn Jepson.*

XVIII. *The Deserts and Desert Flora of the West. By LeRoy Abrams.*

XIX. *The Marine Flora of the Pacific Coast. By William Albert Setchell.*—A great variety of climatic and soil conditions has given birth to diverse and variable flora, and whether one considers it from the "esthetic, the systematic, the genetic or the ecologic" standpoint, his impressions will be compelling. These chapters present the flora by its geographical provinces and give lists of localities of special botanical interest.

The stories of the Big Tree, "the most remarkable member of the earth's silva," and of its groves; of the coast redwood, "the tallest tree on earth," and of other members of this profuse coniferous flora, are of delightful, if brief, interest.

Into the floral assemblages have been intruded the plants of the desert. As far back as the close of the Cretaceous the Mexican plateau began to grow arid, and here and thereafter "drought resisting plants were taking form." "Here originated the cacti, yuccas, dasylirions" and most of the American desert fauna, and thence they spread north after the glacial period and the increase of arid conditions. The Grand Canyon, the Petrified Forests, the Mohave and Painted Deserts and their floras are considered in Professor Abrams's absorbing chapter, which closes with the assurance that "to come upon any understanding of the strange fascination of this land of little rain . . . one must move out into their open spaces; become a part of their boundless silence; face their trackless sands and bare mountain reaches in the wonderful opalescent light of sunsets and sunrises; gain an insight into the significance of the curious adaptations of plant and animal life, and of the page of earth's physical history laid bare in their reft gorges."

In the account of the marine flora special note is taken of its "chief glory," the kelps; numerous in species, often of enormous size, vastly surpassing those of the Atlantic; their forests, the nests of peculiar fishes, and their commercial possibilities still largely unexploited.

XX. *Burbank's Gardens. By Vernon L. Kellogg.*—Essentially a personal tribute happily without advertising matter.

XXI. *Ethnology of the Pacific Coast. By T. T. Waterman.*—With maps of the southwest and north showing the present location of Indian tribes, the distribution, history and tribal customs of the aborigines are passed in condensed but effective review.

XXII. *Astronomical Observatories. By R. G. Aitkin.*—This is a history of the progress of astronomical observation and of the development of observatories.

XXIII. *Museums of the Pacific Coast. By Barton W. Evermann.*—A brief directory of museums of science, art and history.

XXIV. *Agricultural Development of the Pacific Coast. By E. J. Wickson.*—Beginning with the agriculture of the prehistoric peoples, these activities through the Spanish occupation and into the "American period," the author devotes his chapter largely to enumerating factors fundamental to the future development of agriculture; among them he argues with strong reason the essential superiority of the soils of the arid regions when brought under irrigation.

XXV. *Some Notable Irrigation and Hydro-electrical Developments. By C. E. Grunsky.*—Here the actual achievements of irrigation referred to in the preceding chapter are the subject matter. The projects of the U. S. Reclamation Service and a large number of private undertakings for irrigation and power are taken into account. No irrigation bonds are offered for sale.

XXVI. *Chemical Resources and Industries. By Harry East Miller.*—A review of the chemical industries, based largely on natural mineral and agricultural products.

XXVII. *Mountaineering on the Pacific Coast. By Joseph N. LeConte.*—For the man or woman who accepts no challenge from any upturned angle of the earth, this chapter is a suggestion of things to do.

XXVIII. *Outdoor Life and the Fine Arts. By John Galen Howard.*—A pleasant account of the development of the Forest Theater and Mountain Plays, of the combination of out-of-doors with the drama, to which the western climate has lent the guarantee of success.

XXIX. *Literary Landmarks of the Pacific Coast. By S. S. Seward, Jr.*—Bret Harte, Mark Twain and Stevenson, in passing; Ambrose Bierce (lately discovered by the East), Joaquin Miller, Edwin Markham, Edward Roland Sill, John Muir, Jack London, make a pyramid of "land-marks" of which the capstone is only laid when we add the name of Gelett Burgess.

XXX. *Legal and Political Development of the Pacific Coast States. By Orrin K. McMurray.*—A suggestive account of the development of the legal code from the unformed code of the miners' camps and frontier civilization, a few permanent effects of the Spanish procedure and a brief sketch of the later history of jurisprudence and its controlling conditions.

XXXI. *Scenic Excursions. By A. O. Leuschner.*—A condensed Baedeker of the out-of-doors to a multitude of delectable spots, with the price per spot.

The form of the book, 12mo, makes it handy for the pocket, but as for the paper and typography, these meritorious essays must feel strangely indecorous in their black-and-tan dress of fat, round, gray-black type on yellow paper, most unhappily tiring to the eyes.

JOHN M. CLARKE

Catalogue of the Freshwater Fishes of Africa in the British Museum. Vol. III. By G. A. BOULENGER. London, 1915.

It was originally intended to complete the account of the freshwater fishes of Africa in three volumes, but so many new species have accumulated during the progress of the work, that a fourth volume has become necessary. The third volume, now issued, is principally concerned with the Cichlidæ, but also includes a number of smaller families. In all, 394 species are described, the great majority also figured. No less than 231 of these species have been first described by Dr. Boulenger, whose labors on African fishes far exceed in magnitude and importance those of any other writer, or perhaps all other writers combined.

The Cichlidæ are of particular interest because of their abundance in Africa and South America, suggesting to some minds a former direct land connection between these continents. In this case we fortunately have positive evidence of a former more northern distribution, a genus of these fishes (*Priscacara*) being found in the Eocene of Wyoming. Boulenger recognizes no less than 41 genera of African Cichlidæ, all distinct from the 26 genera which Eigenmann catalogues for the neotropical region. No less than 21 genera are confined to Lake Tanganyika, so far as the records show. In the large genera *Tilapia* and *Paratilapia* we are told that the scales are "cycloid or ctenoid," but there is some confusion in the use of these terms, owing to the fact that weak and minute ctenoid structures are overlooked, and the scales pass as cycloid, as for example in *Tilapia nilotica.* For a correct understanding of the scale-structure of all these genera, the scales must be removed from the fishes and examined microscopically.

The Cyprinodontidæ or Pœciliidæ present a very different case from that of the Cichlids, having still a northern distribution, and pos-

sessing genera common to Africa and America. The African genera are only six, whereas we have very numerous genera in North America. Three, each with a single species, are exclusive African, one being from Lake Tanganyika (a remarkable form, with ctenoid scales), one from the Cameroon-Niger region (the exposed surface of the scales said to be regularly hexagonal), and one which is really Palæarctic, being found on the northern slope of the Atlas Mountains, in hot springs. The last mentioned, *Tellia,* is like *Cyprinodon,* with the pelvic fins wholly absent. Eighteen species are placed in *Fundulus*—the genus which is persecuted every summer by the biologists at Woods Hole. Forty-two others are referred to *Aplocheilus,* which Dr. Boulenger calls *Haplochilus,* the only distinguishing feature of which appears to be the fact that the dorsal fin is placed more posteriorly. Other characters have been cited by authors, but they apparently break down in dealing with the African fauna. The weakness of *Haplochilus,* as now defined, is indicated by the fact that in 1911 Dr. Boulenger himself described the sexes of a species (*Fundulus gardneri*) as two different things, placing the male in *Fundulus* and the female in *Haplochilus.* Another species, *Haplochilus liberiensis,* certainly seems nearer to *F. gardneri* than the latter is to some other species assigned to *Fundulus.* Thus we have a more or less continuous series, which is divided into two genera principally on grounds of convenience, by a character which in most of the species can be recognized at a glance. The only objection to this arises from the possibility that the arrangement is artificial, and that our American *Haplochilus* have no immediate relationship with those of Asia and Africa. If we use the single character employed by Boulenger, our *Fundulus floripinnis* must be referred to *Haplochilus,* where in fact Cope originally placed it.

Boulenger's "Freshwater Fishes of Africa" is a book which, although strictly technical, ought to find a place in general zoological laboratories, because it serves so well to illustrate the modifications which characterize genera and species. Very rarely can we see such complete series as are represented by the illustrations, and with the relatively scanty materials at our command, we are little able to appreciate the real diversity of animal life.

T. D. A. Cockerell

University of Colorado

A BIBLIOGRAPHY OF FISHES TO BE PUBLISHED

The time is ripe—and has, indeed, long been ripe—for the publication of a carefully prepared bibliography of fishes, to cover the entire range of the subject: fishes fossil as well as living, and fishes from many points of view, such as anatomy, physiology, embryology, pathology, parasitology, distribution, taxonomy, everything in short excepting matters which deal with clerical details of the fisheries. Such a compilation, it is clear, means much for this branch of zoology; for the literature of the fishes is vast, widely scattered and ill digested. In fact, I believe that there is hardly an investigator to-day who has not been obliged, needlessly, to give weeks or months of his time to searching for references.

The importance of such a bibliography was brought home to me about 1890: at that time I began the work of collecting references to be used in my studies, and as years passed I was able to build up a card-catalogue giving author and subject, which proved indispensable. Later my catalogue became known to correspondents, who in turn found it of use in their studies; and they, for their part, were generous in contributing references, and thus added notably to its value. It next, through the kindness of the Smithsonian Institution, absorbed the bibliography which Professor Goode undertook to publish and which his death left unfinished. Thus the value of the work became greater year by year. About 1910 the American Museum of Natural History allowed me secretarial help in the direction of editing the catalogue for publication. And thereafter, for about a year and a half this secretarial work was carefully carried on under the supervision of my colleague, Dr. Louis Hussakof, and since 1914 by Dr. C. R. Eastman, of the American Museum.

The scope of the undertaking may be understood when one considers that nearly 50,000 references are brought together. These have been gathered from all sources, notably from all accessible bibliographies, serial publications and book catalogues. Finally, the effort was made to complete the lists of titles by bibliographies secured in so far as possible from authors themselves. To this end circulars were sent out to several hundred writers on ichthyology, many of whom responded cordially.

There still remain, however, a number of individual writers who have not contributed the titles of their publications. I have, accordingly, been led to publish the present note in the hope that any who have not already sent to Dr. Eastman or myself their bibliographies may be reminded that we are especially anxious to make the work as complete as possible. And we urge that their lists be sent in without delay, for the work is undergoing its final revision and the first volume is shortly to go to press. This is the "author's" volume which will consist of about 1,000 pages and include under the names of writers a serial list of their publications. The second, or "subject" volume, will be a classified index of the titles in volume I. Here one has access to special papers in the various branches, for example, in anatomy, distribution, embryology.

Bashford Dean
American Museum of Natural History,
New York

SPECIAL ARTICLES

THE ACTION OF POTASSIUM CYANIDE WHEN INTRODUCED INTO TISSUES OF A PLANT

In an issue of Science last autumn[1] Professor Sanford mentioned some experiments conducted in California in destroying the Australian bug, *Icerya purchasi,* by the use of potassium cyanide placed in the tissues of the tree. Since that issue, a number of articles or notes have appeared from time to time discussing the possibility of the use of potassium cyanide for the destruction of various sucking and wood-boring insects, but no experimental evidence was given as to how the cyanide acted in the tree or why it should kill the insects. During the winter and spring, a few experiments were conducted along these lines. The first work was done on geraniums. A hole was made near the base of the plant and a small piece of potassium cyanide, about half the size of a pea, was placed in the stem. A split piece of rubber tubing was placed around the stem and sealed tight with paraffin to prevent leakage. Twenty-four hours later the plant was examined for the presence of cyanide. The potassium cyanide had disappeared, but the odor of cyanide was present at the wound. Sections of the stem were cut longitudinally and crosswise and tested by the Prussian blue reaction. Thick sections were placed in a 5 per cent. solution of caustic potash for about a minute, then transferred to a solution containing 2½ per cent. of ferrous sulfate and 1 per cent. of ferric chloride, heated to 60° C. After ten minutes, they were placed in a mixture of one part hydrochloric acid to six parts water. When cyanide was present, the sections showed the Prussian blue reaction in from ten to fifteen minutes.

From Mr. Sanford's article, one would expect the reaction to show in the vascular bundles or in the water-conducting tissue of the plant. Such, however, was not the case. Cyanide showed only in the outer cortical layer and in the inner pith cells, the strongest, however, in the cortical layer. The lignified tissue gave no reaction. Positive tests could be obtained for a distance of about one foot above the wound, but only about an inch or an inch and a half below the wound.

Other treated plants were allowed to continue for several days, to study the effects on the plant. It was noticed that whenever the cyanide reached the axle of a leaf, the petiole withered and died within a half-inch of the base, the leaf hanging down from the plant. Similar results were obtained whenever the cyanide reached a succulent offshoot, the cyanide seeming to blister the tissue. Tests for cyanide could not be obtained beyond the injured portion which was at the point of attachment to the stem. The reaction at that

[1] Vol. XL., No. 1032, page 519.

point, however, was stronger than on the main stem, either above or below the branch. Furthermore, it was noticed that in passing out an older lateral branch, the cyanide showed a preference for the upper side of the limb. The question arises, How does the cyanide pass through such a plant? If it passed through the vascular bundles without giving a Prussian blue test, the oxidases in that tissue would have been destroyed, but even in the stems in which a positive test could be obtained, in the cellulose tissue an oxidase test could still be obtained in the vascular bundles by both benzidine and by alpha napthol, although the reaction was not as strong as in the normal plant.

If the cyanide does not pass through the sap, one would naturally assume that it must pass up by diffusion. The facts, however, do not point to such a conclusion. Diffusion should be as rapid or almost as rapid down the stem of the plant as up the stem, which was not the case. On reaching the succulent tissue, one would expect diffusion to be more rapid, but the opposite is true. A histological examination of the tissues of the plant shows the older stems, with large intercellular spaces in the cellulose tissue, particularly in the cortical layer. The young succulent side-shoots have small or no intercellular spaces.

One might conceive of the cyanide passing up through the plant in the form of a gas. Potassium cyanide would very readily be broken up by some of the organic acids in the plant, probably carbonic acid, liberating hydrocyanic acid which could then move up between the cells of the plant without seriously injuring them, except where present in great excess. The cells would absorb some of the hydrocyanic acid, but if the amount be not too great, the cell would oxidize it by its oxidases. Granting its passage as a gas would explain its passage upward faster than downward. It would also explain why, in going out a lateral branch, it travels on the upper side rather than on the lower side and why, on reaching a succulent tissue, with small or no intercellular spaces, it is stopped in its flow. Such tissue with its greater water content would tend to dissolve the hydrocyanic in larger quantities than the cell can withstand, this resulting in the death of the tissue.

A comparative experiment was performed by introducing into the stem of the plant, by means of a siphon tube, a solution of hydrocyanic acid in distilled water. The siphon was arranged so that the pressure was just sufficient to hold the liquid against the tissue. The edges of the tube were sealed to the stem by means of paraffin. This geranium, upon examination in twenty-four hours, showed the hydrocyanic strongest in the vascular bundles rather than in the cellulose tissue. Diffusion also took place downward, as a very strong reaction for cyanide was obtained, as far as the base of the plant, eight inches below the wound. Diffusion downward, however, was stronger through the cellulose tissue than in the conducting tissue. There seemed to be no difference at the side branches—no stoppage of the hydrocyanic in its course as was found where a crystal of potassium cyanide had been introduced. The results of this experiment where the passage was by diffusion and by conduction through the vascular system was quite distinct from where the crystal of potassium cyanide had been introduced. Potassium cyanide was next tried on an apple tree during March, when the weather was still cold. At the end of two days, the limb into which the cyanide had been introduced was cut off and tested for cyanide. The test showed the cyanide only in the woody tissue; in fact, by microscopic examination, it was shown to be only in the lumen of the larger tracheæ. The distance traveled, however, was not more than two inches. Not all the KCN had disappeared from the opening, probably due to the small amount of sap in the tree and the cold weather. It was noticed that a discoloration appeared in the tissue through which the cyanide had passed. This discoloration agreed exactly with the area in which a Prussian blue reaction could be obtained. When the sap increased in the trees, further tests were made. It was found, however, that although potassium cyanide disappeared within two days, April 17–19, the hydrocyanic acid had only traveled

about a foot and a half through the woody portion of the stem. No Prussian blue reaction could be obtained in the bark or in the cambium layer, at any time. Thinking that it might be possible that the cyanide would pass rapidly through the tracheæ and later be destroyed, making a positive cyanide test impossible, a large apple tree was selected for a further experiment. Near the base a hole three quarters of an inch in diameter was bored into the wood. This was plugged up with potassium cyanide, corked and the edges of the cork sealed with collodion. A number of other holes were bored into the tree, one at a distance of a foot above the cyanide opening and four others at varying distances up the tree. These holes were about a half inch in diameter and one and one half to two inches in depth. Rubber stoppers through which were passed glass tubes, sealed at the outer end and containing distilled water, were placed in these holes and the edges sealed with collodion. These were quite comparable to the burrows of a wood-boring insect, and as hydrocyanic is very soluble in water, the water in the tube would dissolve any hydrocyanic passing into these holes. With a negative test in these tubes, the hope of destroying wood-borers extensively through the tree would vanish. The tubes were examined from day to day for the presence of cyanide. Although, by the 22d, all the cyanide had disappeared from the opening, no test could be obtained in any of the tubes, either by precipitation with silver nitrate or by the Prussian blue reaction. On April 29, the tree was examined to determine the path of the hydrocyanic acid. It was found that the hydrocyanic acid had passed through an area varying from an inch to a half inch in diameter, beginning at the upper side of the hole, next to the cork, and had traveled through the woody tissue, missing the first hole containing a tube, by about two inches, continuing up the tree to a height of about seven feet, where the test became weaker and finally negative. The highest opening in the tree, which was at a height of about six and one half feet, was missed by less than a half inch, the course of the hydrocyanic having been interrupted by a knot which it had gone around or otherwise a positive test might have been obtained in this tube.

In the other trees, it was noticed that the hydrocyanic passed through a particular area which had its point of departure on the upper side of the cyanide hole, next to the cork. If the hole drilled in the tree is at right angles to the tree, the hydrocyanic passes up evenly from the upper side of the hole but does not diffuse throughout the wood.

From these experiments, it seems that unless one could collect their wood-borers and have them located definitely in the tree, that treatment would be of little or no value. It might be locally applied where the wood-borer is definitely located, by drilling a hole just beneath it and introducing the potassium cyanide or where the borer has made a large burrow one might successfully introduce the potassium cyanide into the burrow. For the larger number of wood-borers, such as inhabit our oaks—boring in the cambium layer—this treatment would have little or no value, as the hydrocyanic does not travel in the cambium but only through the old tracheæ. For sucking insects, which feed at the vascular bundles, it does not seem that the cyanide could be successfully used. In the light of these experiments, it seems that the Spanish broom upon which Professor Sanford destroyed his Australian bugs, must have a peculiar structure to permit the cyanide to pass through an area reached by the Australian bug. If it is a semi-woody plant, similar to the geranium, it would be conceivable that hydrocyanic acid would pass through the cortical layer and be of some value. To be successful against sucking insects, it would have to pass through the vascular system where the insects feed or between the outer surface and the vascular system. The latter is possible in herbaceous or semi-woody plants but would greatly endanger the life of the plant.

In woody trees, where its path is in the older tracheæ, there seems to be no danger to the tree, as these tracheæ are already dead. Excessive amounts might prove dangerous. It is conceivable that the amount used by Professor

Sanford in his peach tree would act as a stimulant to the tree as in other work upon the effects of fumigating greenhouse plants with hydrocyanic acid evidence has been obtained of stimulation, the results of which will be published later.

William Moore,
A. G. Ruggles
Division of Entomology,
Minnesota Experiment Station,
St. Paul, Minn.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE SECTION B, PHYSICS

By combining their interests Section B of the American Association for the Advancement of Science and the American Physical Society always have exceedingly profitable joint meetings; meetings at which nearly all the progressive physicists of the States and of Canada become personally acquainted and from which they return to their respective laboratories taking with them the inspiration of new ideas and the cheer of many friendships.

The recent Philadelphia meeting, at which President Ernest Merritt of the American Physical Society and Vice-president Anthony Zeleny of the American Association for the Advancement of Science alternately presided, was typical of these delightful and helpful occasions.

The address of the retiring vice-president and chairman of Section B, Dr. A. D. Cole, was on "Recent Evidence for the Existence of the Nucleus Atom."

The structure of the atom has been and still is *the* goal of modern physical investigation. Possibly it may never be attained, but the failure to attain it should not be regretted so long as endeavors to this end continue to yield, as heretofore, such valuable incidental discoveries. Dr. Cole's address, published in full in the January 15 issue of Science, reviews a number of the more recent of these discoveries, and also gives references to many original papers. Both addresses and references will be of great assistance to every physicist who really is interested, whether actively or passively, in that baffling yet enticing subject, the structure of the atom.

The usual symposium consisted, at this meeting, of addresses on "The Use of Dimensional Equations," by Dr. Edgar Buckingham and Dr. A. C. Lunn, followed by discussions by Dr. W. S. Franklin, Dr. A. G. Webster, and others.

Dr. Buckingham's address, following somewhat his paper in the October, 1914, issue of the *Physical Review,* emphasized the practical use of dimensional equations in the logical or mathematical discussion of physical problems.

Dr. Lunn considered the mathematical and metaphysical aspects of the subject, and so interestingly that it is to be hoped that he too will publish in full his contributions to this subject.

The discussion and remarks that followed the principal papers indicated a recognition of the importance of the subject, but also a frank admission that its daily use in the laboratory and the classroom is, perhaps, rather limited.

The sectional committee nominated, and the general committee later elected, Professor Frederick Slate vice-president and chairman of Section B. Professor Slate, however, was unable to serve and a new election therefore was necessary. This was completed at the April meeting of the Council, resulting in the selection of Dr. E. P. Lewis, of the University of California.

At present the officers of Section B are as follows:

Vice-president and Chairman of the Section, E. Percival Lewis, University of California, Berkeley, Cal.

Secretary, William J. Humphreys, Weather Bureau, Washington, D. C.

Member of Council, Gordon F. Hull, Dartmouth College, Hanover, N. H.

Sectional Committee, Vice-president, Philadelphia, Anthony Zeleny; Vice-president, San Francisco and Columbus, E. Percival Lewis; *Secretary,* William J. Humphreys, Weather Secretary, Alfred D. Cole; Anthony Zeleny, 1 year; T. C. Mendenhall, 2 years; Dayton C. Miller, 3 years; George W. Stewart, 4 years;

Robert R. Tatnall, 5 years. Ex-officio: Ernest Merritt, President, American Physical Society; Alfred D. Cole, Secretary, American Physical Society.

Member of General Committee, R. A. Millikan, Chicago.

W. J. HUMPHREYS,
Secretary, Section B

NEW ORLEANS MEETING—AMERICAN CHEMICAL SOCIETY

TITLES AND ABSTRACTS OF PAPERS

OPENING address by A. D. Little, "The Industrial Resources and Opportunities of the South."

CHARLES S. ASH: *Contributions of the Chemist to the Wine Industry.*

J. B. F. HERRESHOFF: *Contributions of the Chemist to the Copper Industry.*

E. T. BEDFORD: *Contributions of the Chemist to the Corn Products Industry.*

JAMES LEWIS RAKE: *Contributions of the Chemist to the Asphalt Industry.*

DAVID WESSON: *Contributions of the Chemist to the Cotton-seed Oil Industry.*

G. S. BROWN: *Contributions of the Chemist to the Cement Industry.*

W. D. HORNE: *Contributions of the Chemist to the Sugar Industry.*

SIDNEY MASON: *Contributions of the Chemist to the Incandescent Gas Mantle Industry.*

FRANKLIN W. HOBBS: *Contributions of the Chemist to the Textile Industry.*

H. WALKER WALLACE: *Contributions of the Chemist to the Fertilizer Industry.*

F. R. HAZARD: *Contributions of the Chemist to the Soda Industry.*

WILLIAM H. TEAS: *Contributions of the Chemist to the Leather Industry.*

JOHN A. WESENER and GEORGE L. TELLER: *Contributions of the Chemist to the Flour Industry.*

GASTON D. THEVENOT: *Contributions of the Chemist to the Brewing Industry.*

R. I. BENTLEY: *Contributions of the Chemist to the Preserved Foods Industry.*

WM. P. MASON: *Contributions of the Chemist to the Potable Water Industry.*

R. C. SCHUPPHAUS: *Contributions of the Chemist to the Celluloid and Nitrocellulose Industry.*

A. A. HOUGHTON: *Contributions of the Chemist to the Glass Industry.*

F. L. MOORE: *Contributions of the Chemist to the Pulp and Paper Industry.*

Public address to the people of New Orleans, by Bernhard C. Hesse, "The Chemists' Contribution to the Industrial Development of the United States —A Record of Achievement."

The above papers have been printed in full in the April issue of the *Journal of Industrial and Engineering Chemistry.*

DIVISION OF AGRICULTURE AND FOOD CHEMISTRY

Floyd W. Robinson, *chairman*
Glen F. Mason, *secretary*

E. H. S. BAILEY and W. S. LONG: *On the Composition of the Seeds of Martynia Louisiana (Unicorn or Devil's Claws).*

This plant, which grows wild through the central west and especially in the dry climate of western Kansas, Colorado and New Mexico, has been investigated with reference to utilizing the oil contained in the seed. It has been found that this seed contains over sixty per cent. of a bland oil, 24.21 per cent. of protein and 4.55 per cent. of starch. An examination of the oil shows that it compares favorably with some edible oils, especially cotton-seed oil. The authors suggest that since the plant is so well adapted to a dry climate, experiments should be made to determine whether it may not be profitably cultivated as an oil-bearing plant.

EDWARD GUDEMAN: *Action of Milk on Colloids.*

W. D. BIGELOW and F. F. FITZGERALD: *The Relation of the Refraction, Specific Gravity and Solids in Tomatoes and Tomato Pulp.*

As a result of the examination of a considerable number of fresh and canned tomatoes, and of pulps made up under known conditions, tables have been constructed to facilitate analytical work. The generalizations given below are within the limits of analytical error. The filtrate referred to is obtained by throwing a sample of tomato pulp, or crushed tomato product, on a folded filter. Raw tomatoes should be cooked previously in a reflux condenser. The solids are determined by drying in vacuo at 70° and under atmospheric pressure at the temperature of boiling water.

Solids of pulp in vacuo = solids of pulp at atmospheric pressure $\times$ 1.085,

Solids of pulp in vacuo = solids of filtrate in vacuo $\times$ 1.125,

Solids of filtrate in vacuo = solids of filtrate at atmospheric pressure $\times$ 1.12.

From the specific gravity of the filtered liquid at 20° C., the per cent. of solids of the pulp (not of the filtrate) may be ascertained from the Windish wine table.[1] The figure 0.05 should be de-

[1] Table V., Bull. 107, Bureau of Chem.

ducted from the percentage of solids given in that table.

The solids in the filtrate may be ascertained from the index of refraction, using Wagner's table for beer and wine extract. This table is applicable without correction to the juice of fresh or canned tomatoes. When applying it to the filtrate from pulp of the usual concentration, the figure 0.17 should be deducted from the percentage of solids as given. If the product has been salted, the sodium chloride should be determined and a corresponding correction made in refractive index.

H. S. Grindley, W. J. Carmichael and C. I. Newlin: *The Influence of one Feedingstuff upon the Digestibility of Another.*

Eight digestion experiments, each of ten days' duration, were made in which each of three rations—wheat flour middlings alone, wheat flour middlings and ground corn combined in the ratio of 1:1, and ground corn alone—were fed to four pigs. The average results as well as the individual data proved that either wheat flour middlings or ground corn in a ration composed of equal parts of each does influence the digestibility of some of the nutrients of the other feed. It is evident from the results that one feedingstuff does influence the digestibility of another.

G. S. Fraps: *Chemical Investigations at the Texas Experiment Station.*

The article gives a synopsis of the chemical investigations at the Texas Experiment Station, including the work of the state chemist, the feed control, Adams projects and the Hatch projects. The work deals chiefly with the composition and properties of soils, the composition and values of fertilizers, the adulteration of feeds, the studies of the nutritive values of feeding stuff.

W. J. Carmichael, C. I. Newlin and H. S. Grindley: *Individuality of Pigs as to the Completeness with which they Digest their Feed.*

The results of forty digestion experiments, each of ten days' duration, in which each of four rations were fed to four pigs proved that in some instances one animal gave coefficients of digestibility for protein, dry matter, nitrogen-free extract, and ether extract that were always significantly higher than the corresponding coefficients for another animal even in ten tests with four different rations. In a series of experiments, when different rations were used with the same animals, the coefficients, as a whole, for some animals were constantly higher than those for other animals, which showed a consistent relation with reference to individuality.

W. E. Tottingham: *The Effect of Litters on the Fermentation of Manure.*

Oak shavings, pine shavings and oat straw were incorporated with separate lots of a mixture of fresh horse and cow manures. The changes over a period of twelve weeks were compared with those of a control lot of manure. Dry matter decreased most, by a wide margin, in the straw-littered manure and least in the control. The percentage of the total organic matter soluble in water decreased most in the shavings-littered manures and least in the straw-littered lot. In all the lots the percentage of the total ash soluble in water decreased considerably. The percentage of the total nitrogen soluble in water decreased more in the shavings-littered manures than in the other lots. The percentage of the total nitrogen in the form of ammonia reached its highest value in the control manure. Ammonia production was most sustained in the straw-littered lot. Loss of nitrogen was greatest in the shavings-littered manures and least in the straw-littered lot. Yields of corn and barley in field plot tests have shown only slight superiority of stall manure with straw litter as compared with stall manure with shavings litter.

Chas. P. Fox: *Bread: Weight of an Akron (Ohio) Loaf.*

W. C. Taber: *Tamarind Syrup.*

The tamarind is a leguminous tree found in tropical and semi-tropical countries. The pulp found in the pod is remarkable for its high acidity, often 12 or 15 per cent., and for its high content of sugar, amounting sometimes to 40 per cent. A syrup prepared from this pulp has come into use in the United States as a summer beverage. After dilution with water, this syrup forms a refreshing acid drink. For the purpose of detecting adulterated tamarind syrups, made largely from tartaric or citric acid and sugar, and colored with caramel, a series of syrups were prepared with known amounts of the pulp. The analytical results obtained are of value in indicating the amount of tamarind fruit used in a syrup.

David Klein: *A Survey of the Frozen Egg Industry of Chicago.*

Charles L. Parsons,
Secretary

(To be continued)